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Koizumi et al.

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(54) **IMAGE FORMING APPARATUS THAT SWITCHES BETWEEN A FIRST SUPPLY MODE AND A SECOND SUPPLY MODE**

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(73) Assignee: **Canon Kabushiki Kaisha**, Tokyo (JP)

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Sep. 8, 2015 (JP) ................................ 2015-176977
Mar. 17, 2016 (JP) ................................ 2016-054256

(51) **Int. Cl.**
***G03G 15/00*** (2006.01)
***G03G 21/20*** (2006.01)

(52) **U.S. Cl.**
CPC ......... ***G03G 15/80*** (2013.01); ***G03G 15/5004*** (2013.01); ***G03G 21/20*** (2013.01); *G03G 21/206* (2013.01)

(58) **Field of Classification Search**
CPC ........................... G03G 15/80; G03G 15/5004
USPC ...................................................... 399/88, 82
See application file for complete search history.

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2012/0155911 A1* 6/2012 Hirota ............... G03G 15/5004 399/88

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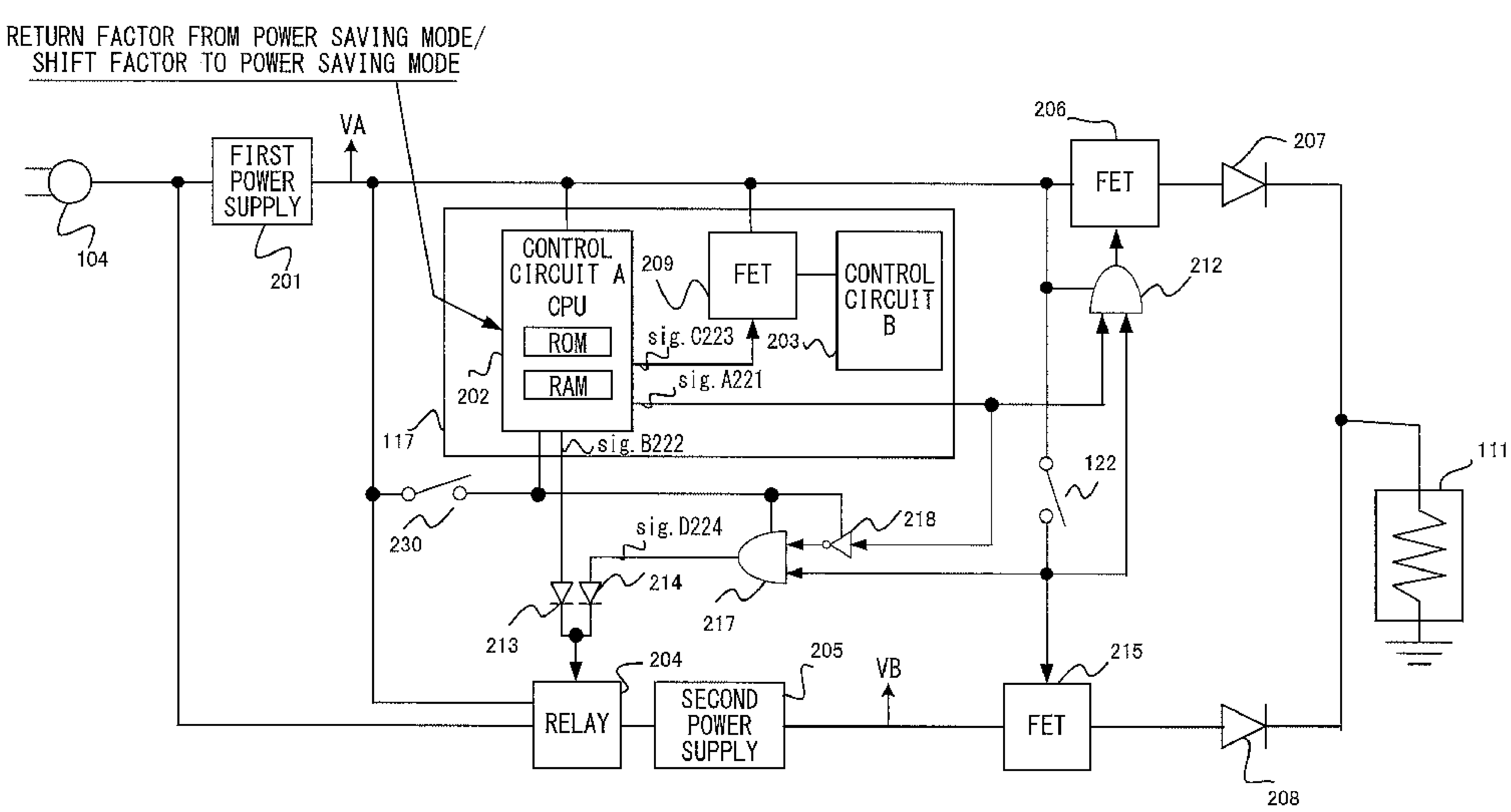
*Primary Examiner* — Billy Lactaoen
(74) *Attorney, Agent, or Firm* — Fitzpatrick, Cella, Harper & Scinto

(57) **ABSTRACT**

An image forming apparatus having a power saving mode includes a first power supply configured to operate in the power saving mode, a second power supply configured to operate in a mode other than the power saving mode, a heater configured to generate heat when power is fed from the first power supply or the second power supply, and a control circuit configured to control power feeding from the first power supply to the heater and activation or stopping of the second power supply. The control circuit is configured to control, based on an instruction to shift from the power saving mode to another mode, so that power feeding from the first power supply to the heater is cut off, and the second power supply is activated to start power feeding from the second power supply to the heater.

**11 Claims, 23 Drawing Sheets**



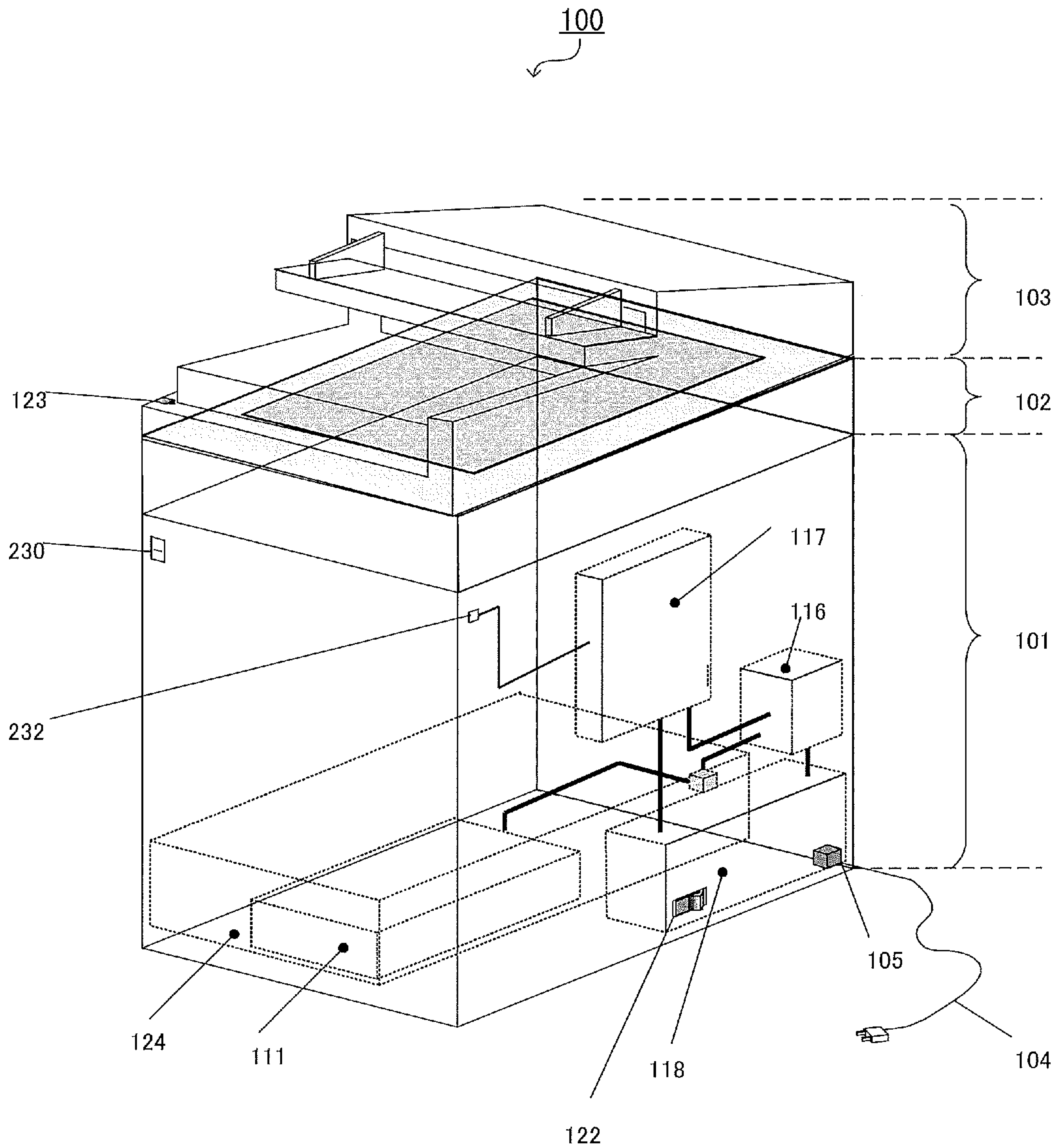
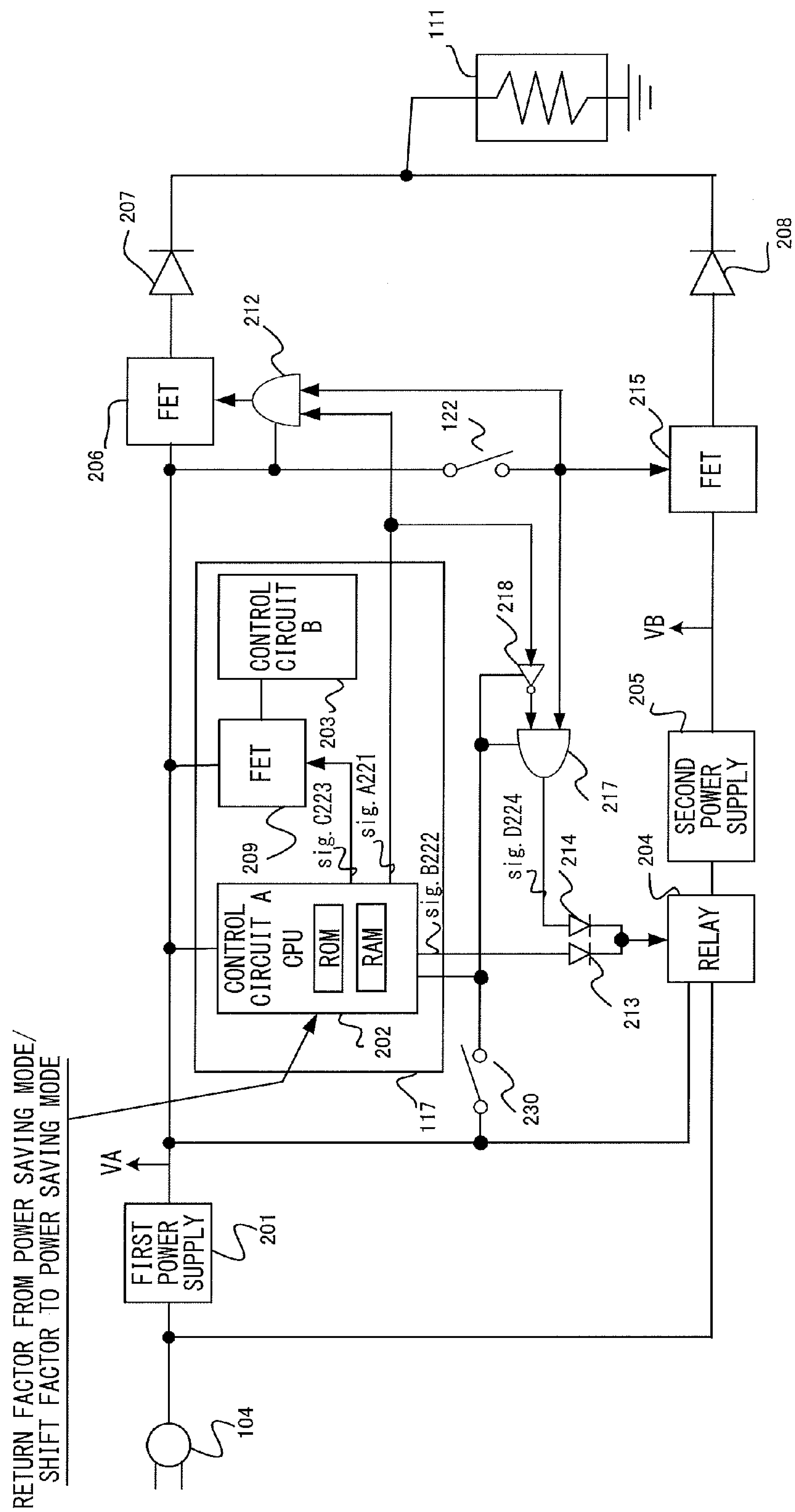



FIG. 1



111
207
208
212
FET
206
122
215
FET
CONTROL CIRCUIT B
218
VB
FET
203
205
sig. A221
sig. C223
209
sig. B222
217
SECOND POWER SUPPLY
sig. D224
214
204
CONTROL CIRCUIT A
CPU
ROM
RAM
RELAY
213
202
RETURN FACTOR FROM POWER SAVING MODE/
SHIFT FACTOR TO POWER SAVING MODE
117
230
VA
FIRST POWER SUPPLY
201
104


FIG. 2

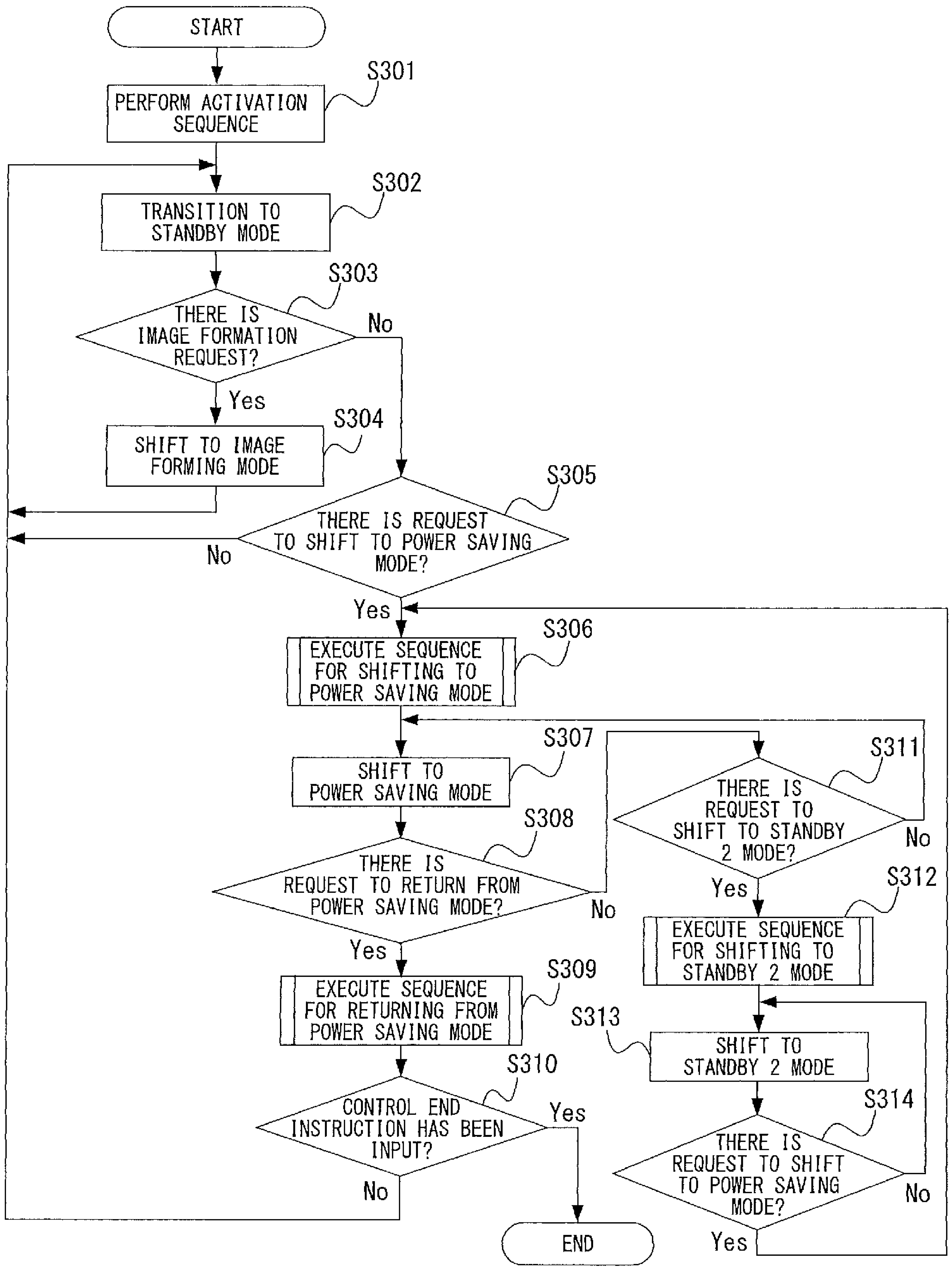

START
PERFORM ACTIVATION SEQUENCE
S301
TRANSITION TO STANDBY MODE
S302
THERE IS IMAGE FORMATION REQUEST?
S303
No
Yes
SHIFT TO IMAGE FORMING MODE
S304
THERE IS REQUEST TO SHIFT TO POWER SAVING MODE?
S305
No
Yes
EXECUTE SEQUENCE FOR SHIFTING TO POWER SAVING MODE
S306
SHIFT TO POWER SAVING MODE
S307
THERE IS REQUEST TO RETURN FROM POWER SAVING MODE?
S308
No
Yes
EXECUTE SEQUENCE FOR RETURNING FROM POWER SAVING MODE
S309
CONTROL END INSTRUCTION HAS BEEN INPUT?
S310
Yes
No
END
THERE IS REQUEST TO SHIFT TO STANDBY 2 MODE?
S311
No
Yes
EXECUTE SEQUENCE FOR SHIFTING TO STANDBY 2 MODE
S312
SHIFT TO STANDBY 2 MODE
S313
THERE IS REQUEST TO SHIFT TO POWER SAVING MODE?
S314
No
Yes

FIG. 3

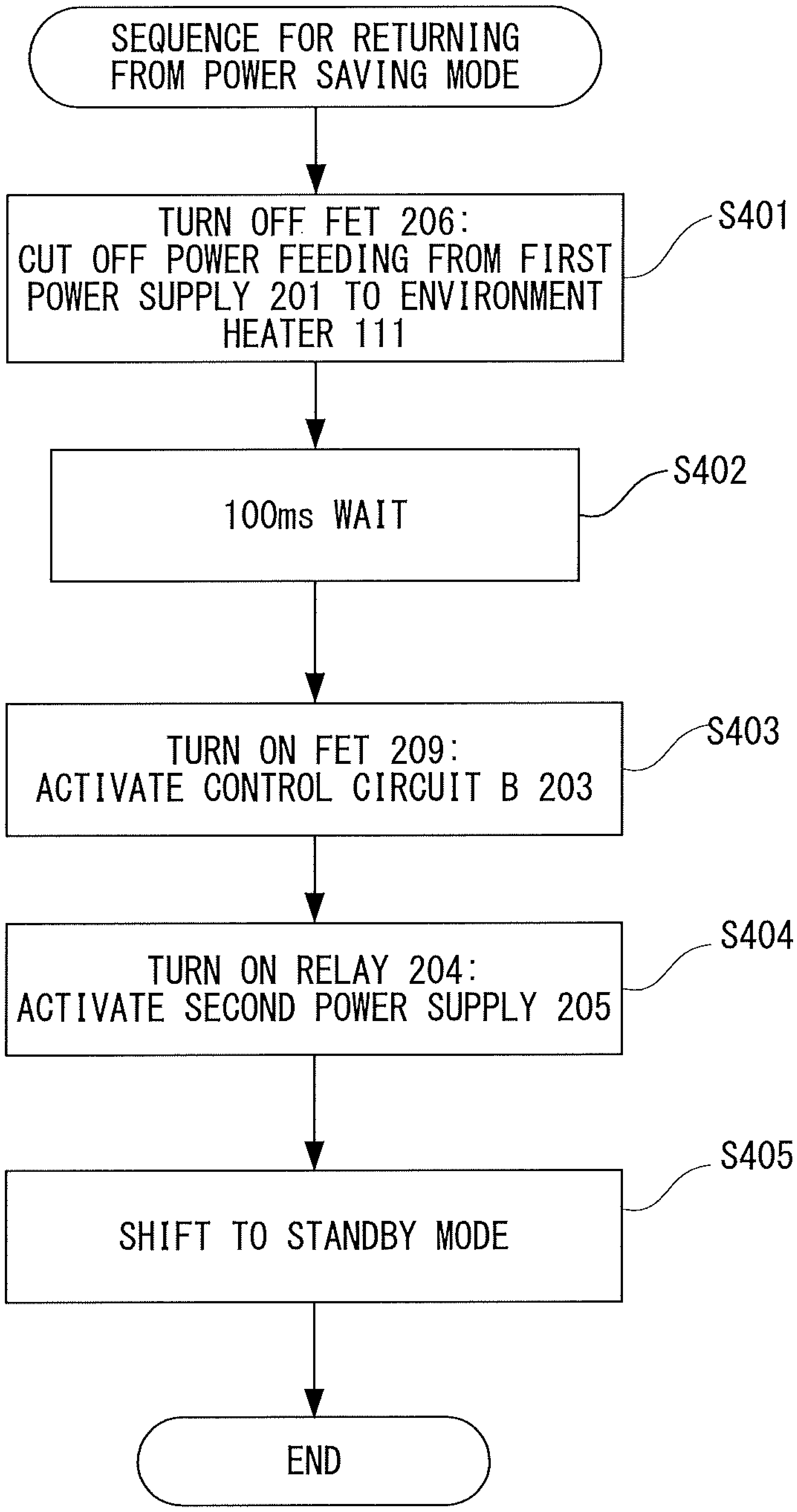

SEQUENCE FOR RETURNING FROM POWER SAVING MODE
TURN OFF FET 206: CUT OFF POWER FEEDING FROM FIRST POWER SUPPLY 201 TO ENVIRONMENT HEATER 111
S401
100ms WAIT
S402
TURN ON FET 209: ACTIVATE CONTROL CIRCUIT B 203
S403
TURN ON RELAY 204: ACTIVATE SECOND POWER SUPPLY 205
S404
SHIFT TO STANDBY MODE
S405
END

FIG. 4

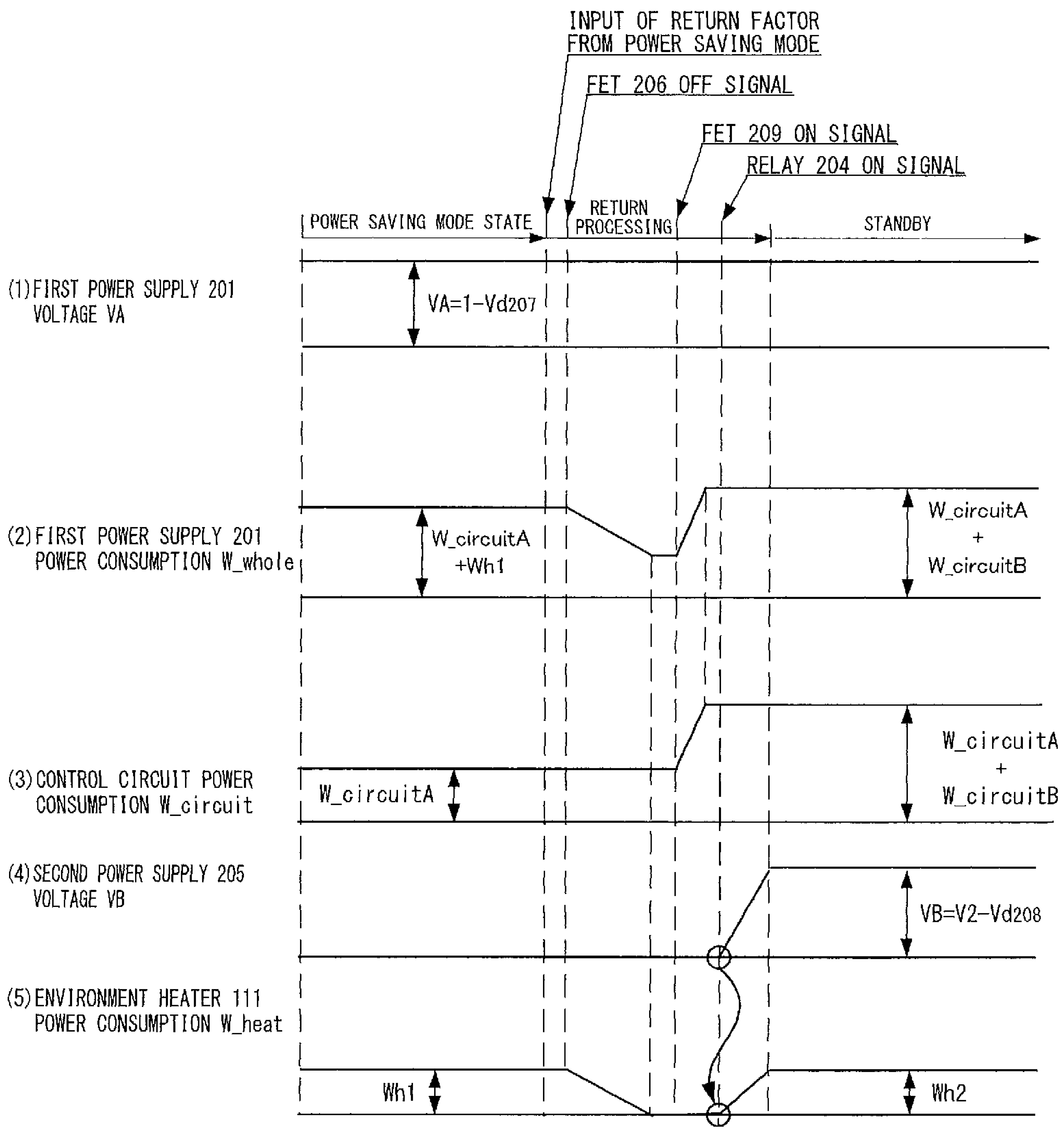

INPUT OF RETURN FACTOR FROM POWER SAVING MODE
FET 206 OFF SIGNAL
FET 209 ON SIGNAL
RELAY 204 ON SIGNAL
POWER SAVING MODE STATE
RETURN PROCESSING
STANDBY
(1) FIRST POWER SUPPLY 201 VOLTAGE VA
VA=1-Vd207
(2) FIRST POWER SUPPLY 201 POWER CONSUMPTION W_whole
W_circuitA +Wh1
W_circuitA + W_circuitB
(3) CONTROL CIRCUIT POWER CONSUMPTION W_circuit
W_circuitA
W_circuitA + W_circuitB
(4) SECOND POWER SUPPLY 205 VOLTAGE VB
VB=V2-Vd208
(5) ENVIRONMENT HEATER 111 POWER CONSUMPTION W_heat
Wh1
Wh2

FIG. 5

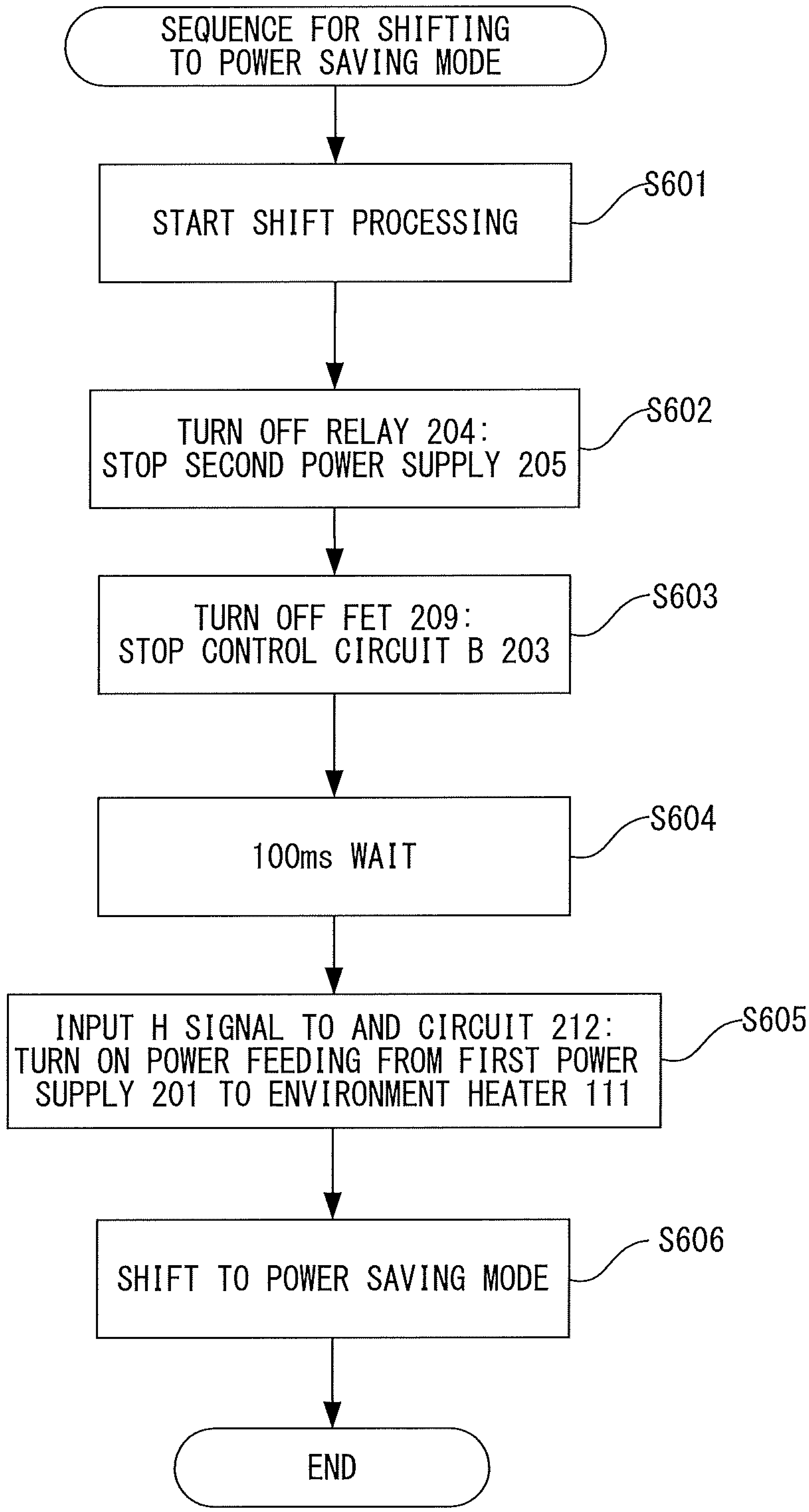

SEQUENCE FOR SHIFTING TO POWER SAVING MODE
START SHIFT PROCESSING
S601
TURN OFF RELAY 204: STOP SECOND POWER SUPPLY 205
S602
TURN OFF FET 209: STOP CONTROL CIRCUIT B 203
S603
100ms WAIT
S604
INPUT H SIGNAL TO AND CIRCUIT 212: TURN ON POWER FEEDING FROM FIRST POWER SUPPLY 201 TO ENVIRONMENT HEATER 111
S605
SHIFT TO POWER SAVING MODE
S606
END

FIG. 6

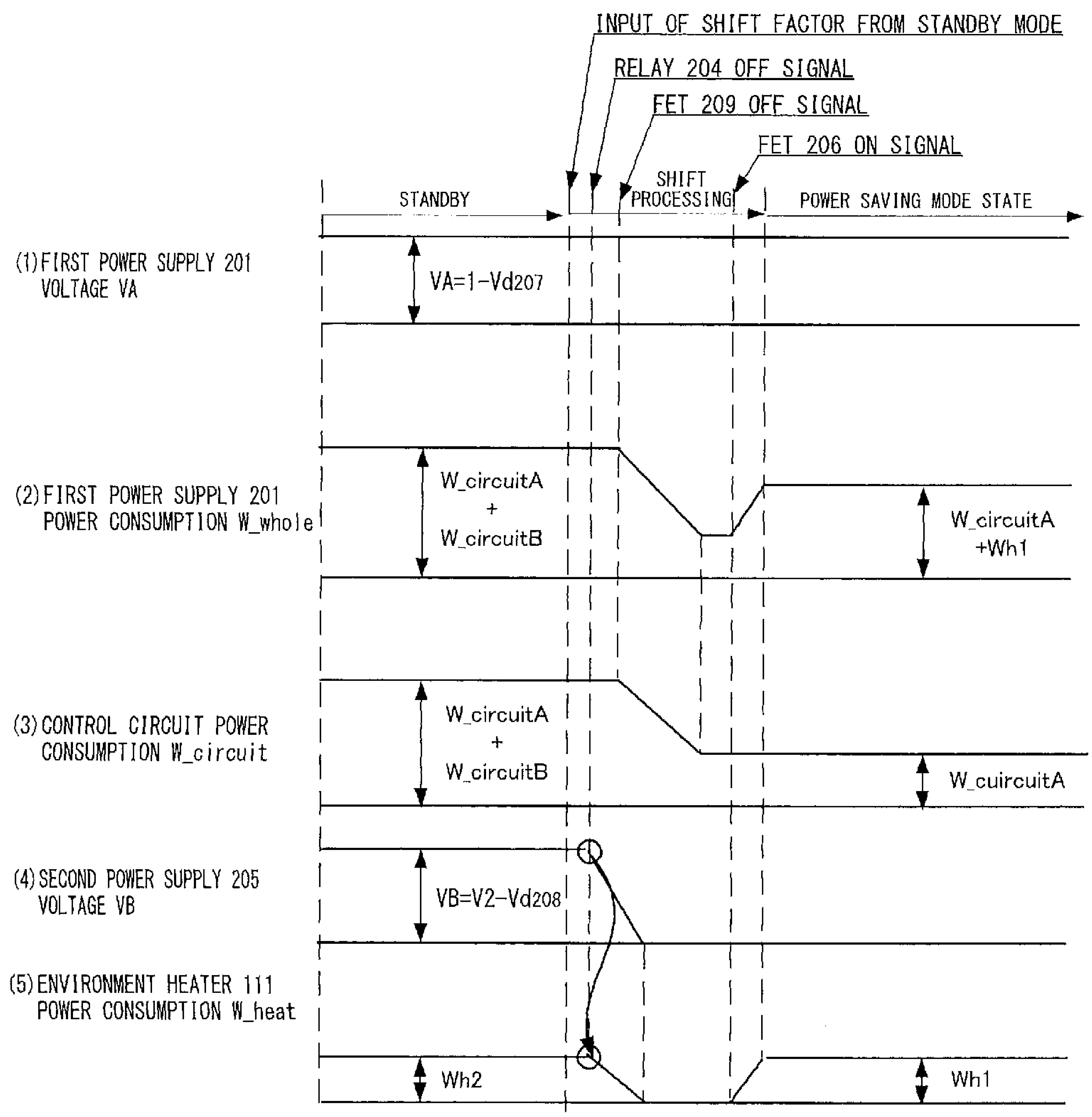

INPUT OF SHIFT FACTOR FROM STANDBY MODE
RELAY 204 OFF SIGNAL
FET 209 OFF SIGNAL
FET 206 ON SIGNAL
STANDBY
SHIFT PROCESSING
POWER SAVING MODE STATE
(1) FIRST POWER SUPPLY 201 VOLTAGE VA
VA=1−Vd207
(2) FIRST POWER SUPPLY 201 POWER CONSUMPTION W_whole
W_circuitA + W_circuitB
W_circuitA +Wh1
(3) CONTROL CIRCUIT POWER CONSUMPTION W_circuit
W_circuitA + W_circuitB
W_cuircuitA
(4) SECOND POWER SUPPLY 205 VOLTAGE VB
VB=V2−Vd208
(5) ENVIRONMENT HEATER 111 POWER CONSUMPTION W_heat
Wh2
Wh1

FIG. 7

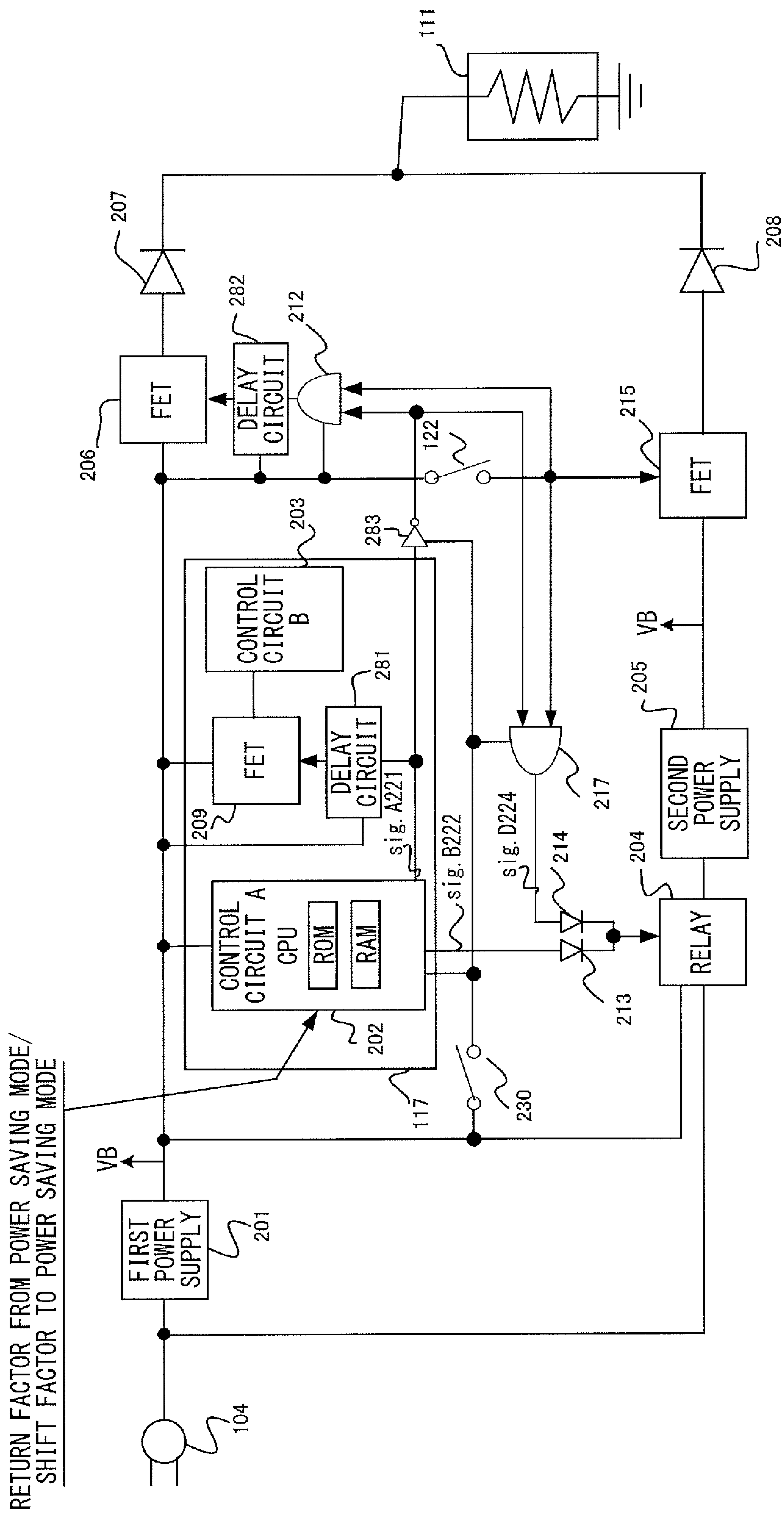

111
207
208
282
212
DELAY CIRCUIT
FET
206
122
215
FET
203
283
CONTROL CIRCUIT B
281
VB
205
FET
DELAY CIRCUIT
209
sig. A221
sig. B222
sig. D224
217
214
204
SECOND POWER SUPPLY
CONTROL CIRCUIT A
CPU
ROM
RAM
RELAY
213
202
RETURN FACTOR FROM POWER SAVING MODE/
SHIFT FACTOR TO POWER SAVING MODE
117
230
VB
FIRST POWER SUPPLY
201
104

FIG. 8

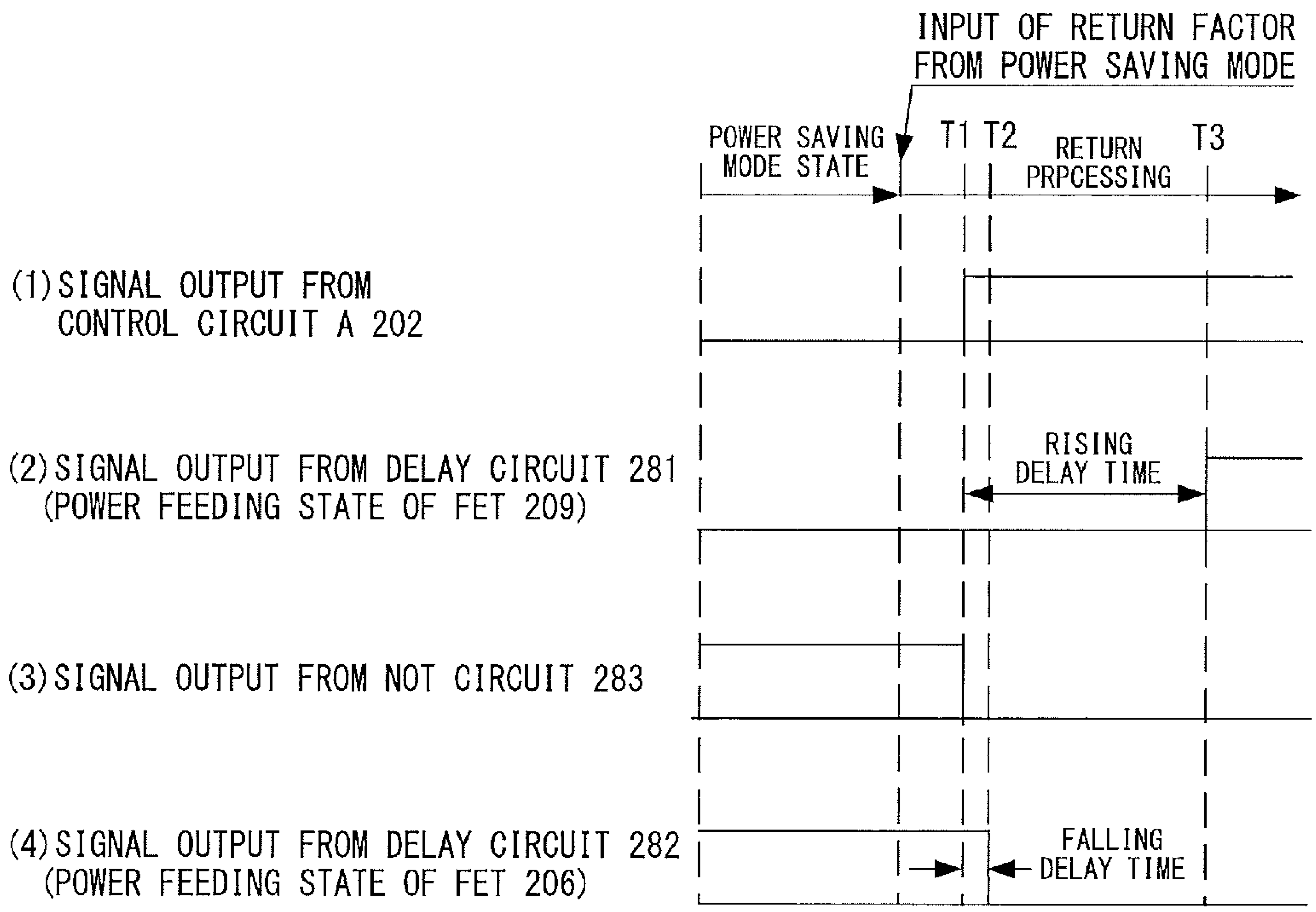

INPUT OF RETURN FACTOR
FROM POWER SAVING MODE
POWER SAVING
MODE STATE
T1 T2
RETURN
PRPCESSING
T3
(1) SIGNAL OUTPUT FROM
CONTROL CIRCUIT A 202
(2) SIGNAL OUTPUT FROM DELAY CIRCUIT 281
(POWER FEEDING STATE OF FET 209)
RISING
DELAY TIME
(3) SIGNAL OUTPUT FROM NOT CIRCUIT 283
(4) SIGNAL OUTPUT FROM DELAY CIRCUIT 282
(POWER FEEDING STATE OF FET 206)
FALLING
DELAY TIME

FIG. 9A

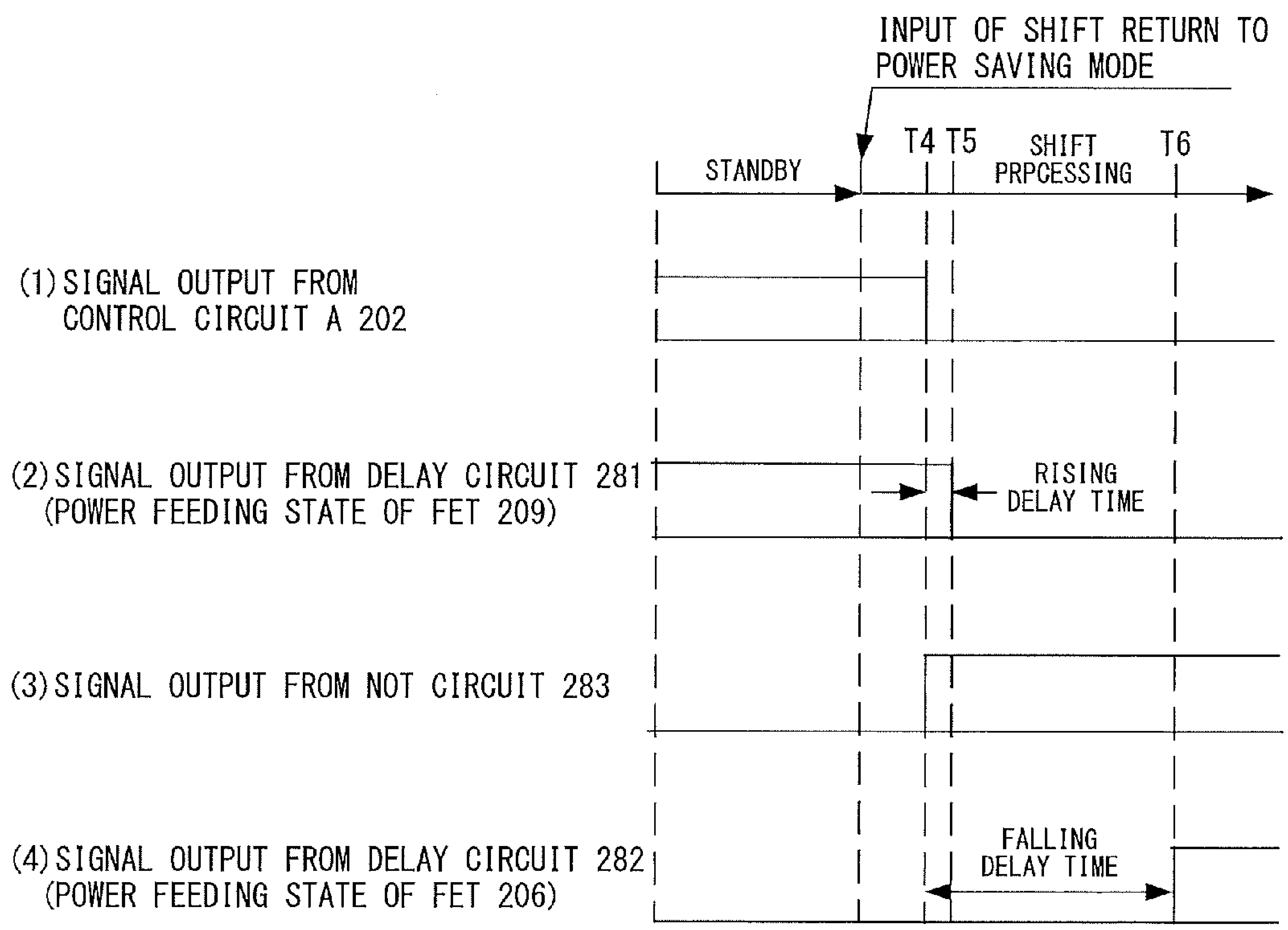

INPUT OF SHIFT RETURN TO
POWER SAVING MODE
STANDBY
T4 T5
SHIFT
PRPCESSING
T6
(1) SIGNAL OUTPUT FROM
CONTROL CIRCUIT A 202
(2) SIGNAL OUTPUT FROM DELAY CIRCUIT 281
(POWER FEEDING STATE OF FET 209)
RISING
DELAY TIME
(3) SIGNAL OUTPUT FROM NOT CIRCUIT 283
(4) SIGNAL OUTPUT FROM DELAY CIRCUIT 282
(POWER FEEDING STATE OF FET 206)
FALLING
DELAY TIME

FIG. 9B

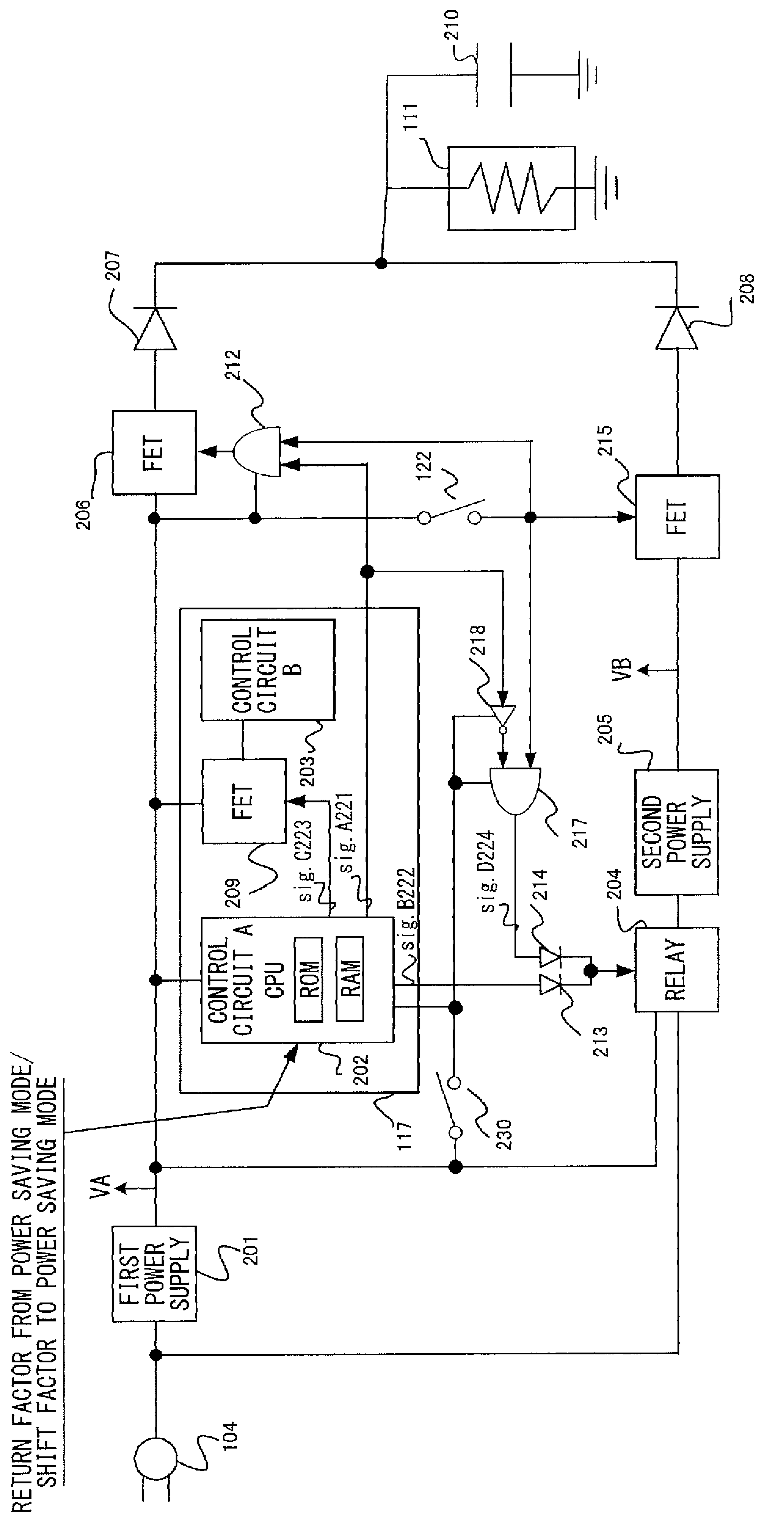

210
111
207
208
212
206
FET
122
215
FET
CONTROL CIRCUIT B
203
218
VB
205
SECOND POWER SUPPLY
FET
209
217
sig. C223
sig. A221
sig. B222
sig. D224
214
204
RELAY
CONTROL CIRCUIT A
CPU
ROM
RAM
202
213
117
230
VA
FIRST POWER SUPPLY
201
104
RETURN FACTOR FROM POWER SAVING MODE/
SHIFT FACTOR TO POWER SAVING MODE

FIG. 10

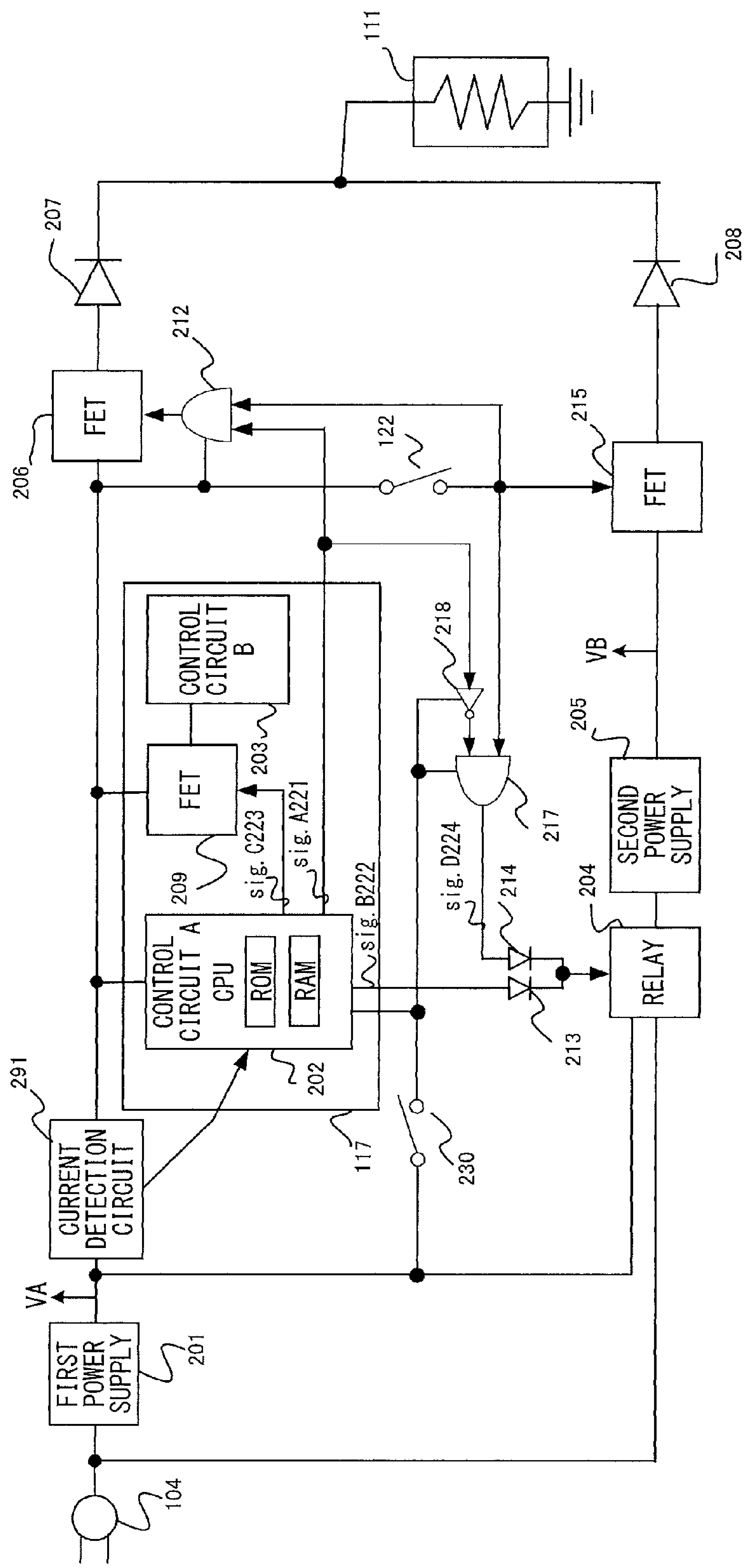

111
207
208
212
FET
206
122
215
FET
218
CONTROL CIRCUIT B
VB
205
203
FET
sig. A221
sig. C223
209
217
SECOND POWER SUPPLY
sig. D224
214
204
sig. B222
CONTROL CIRCUIT A
CPU
ROM
RAM
RELAY
213
202
291
117
230
CURRENT DETECTION CIRCUIT
VA
FIRST POWER SUPPLY
201
104

FIG. 11

STATUS FOR EACH STATE
(ENVIRONMENT SWITCH 122 IS IN ON STATE)

| | sig. A221 | sig. B222 | sig. C223 | sig. D224 | FIRST POWER SUPPLY 201 | SECOND POWER SUPPLY 205 | CONTROL CIRCUIT B 203 | ENVIRONMENT HEATER 111 |
|---|---|---|---|---|---|---|---|---|
| MAIN SWITCH 230 OFF | L | L | L | L | ON | OFF | OFF | ON (1st POWER SUPPLY) |
| POWER SAVING MODE | L | L | L | L | ON | OFF | OFF | ON (1st POWER SUPPLY) |
| STANDBY 2 MODE | H | L | L | H | ON | ON | OFF | ON (2nd POWER SUPPLY) |
| STANDBY 1 MODE IMAGE FORMING MODE | H | H | H | H | ON | ON | ON | ON (2nd POWER SUPPLY) |

FIG. 12A

STATUS FOR EACH STATE
(ENVIRONMENT SWITCH 122 IS IN OFF STATE)

| | sig. A221 | sig. B222 | sig. C223 | sig. D224 | FIRST POWER SUPPLY 201 | SECOND POWER SUPPLY 205 | CONTROL CIRCUIT B 203 | ENVIRONMENT HEATER 111 |
|---|---|---|---|---|---|---|---|---|
| MAIN SWITCH 230 OFF | L | L | L | L | ON | OFF | OFF | OFF |
| POWER SAVING MODE | L | L | L | L | ON | OFF | OFF | OFF |
| STANDBY 2 MODE | H | L | L | L | ON | OFF | OFF | OFF |
| STANDBY 1 MODE IMAGE FORMING MODE | H | H | H | H | ON | ON | ON | OFF |

FIG. 12B

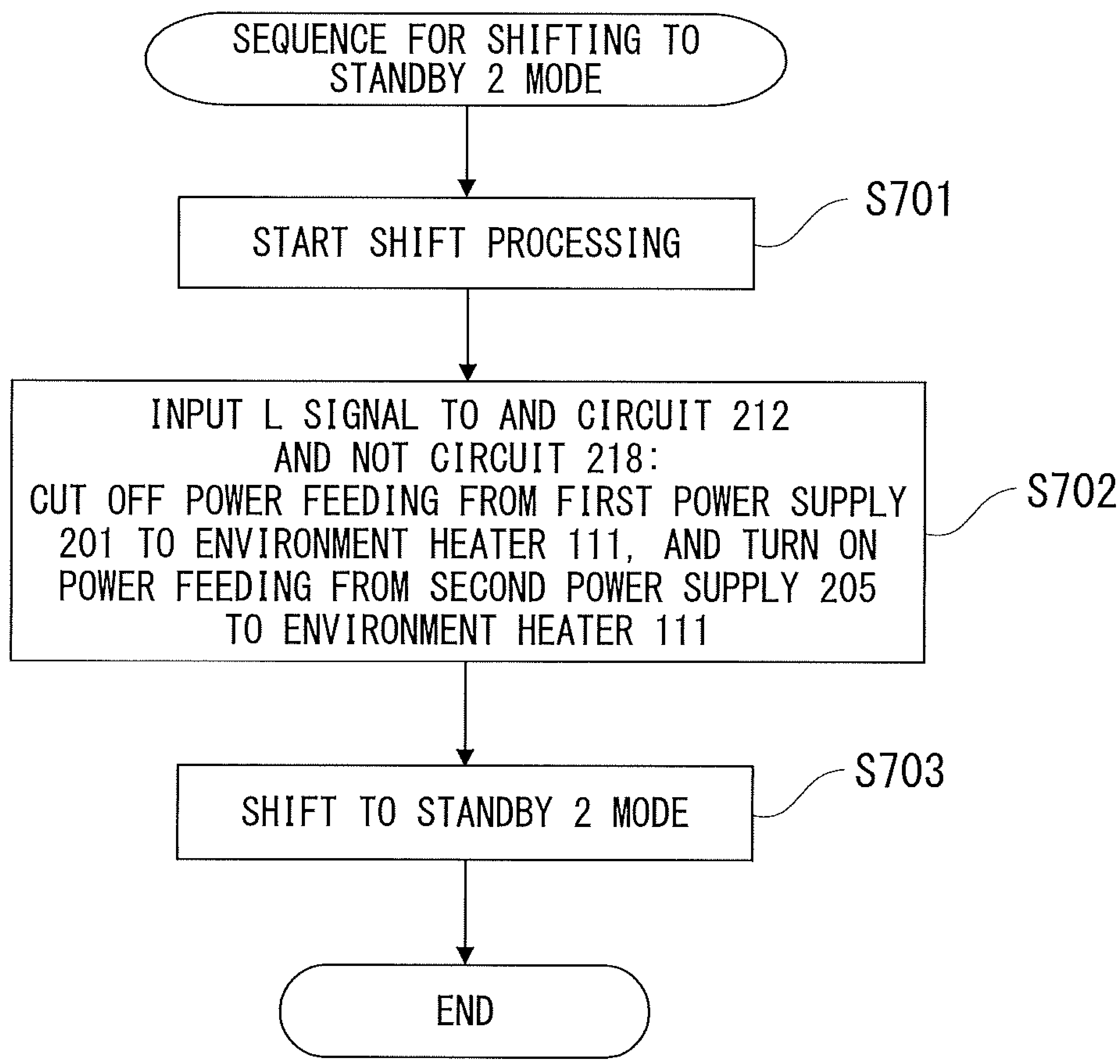

SEQUENCE FOR SHIFTING TO STANDBY 2 MODE
START SHIFT PROCESSING
S701
INPUT L SIGNAL TO AND CIRCUIT 212 AND NOT CIRCUIT 218: CUT OFF POWER FEEDING FROM FIRST POWER SUPPLY 201 TO ENVIRONMENT HEATER 111, AND TURN ON POWER FEEDING FROM SECOND POWER SUPPLY 205 TO ENVIRONMENT HEATER 111
S702
SHIFT TO STANDBY 2 MODE
S703
END

FIG. 13

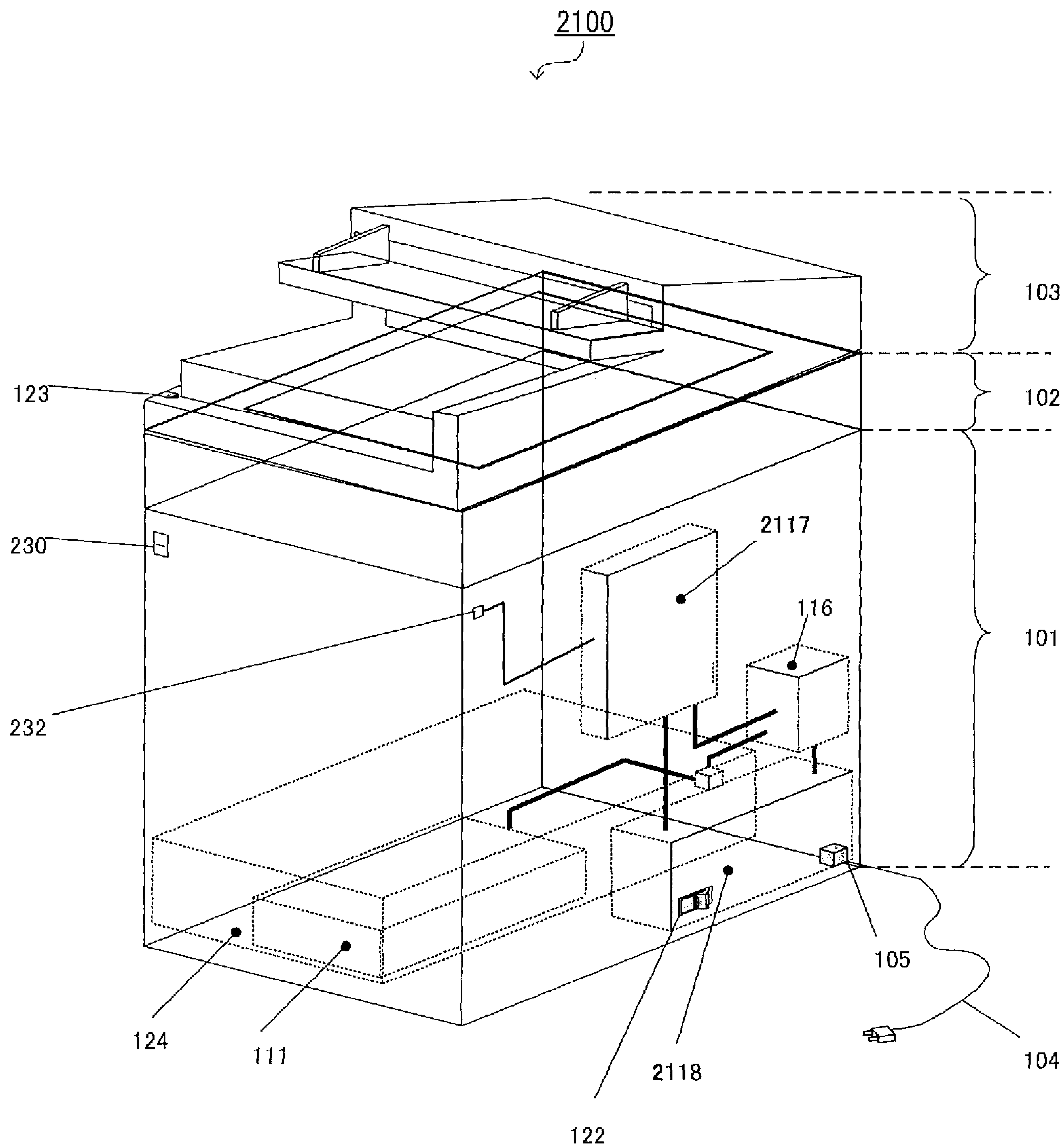



FIG. 14

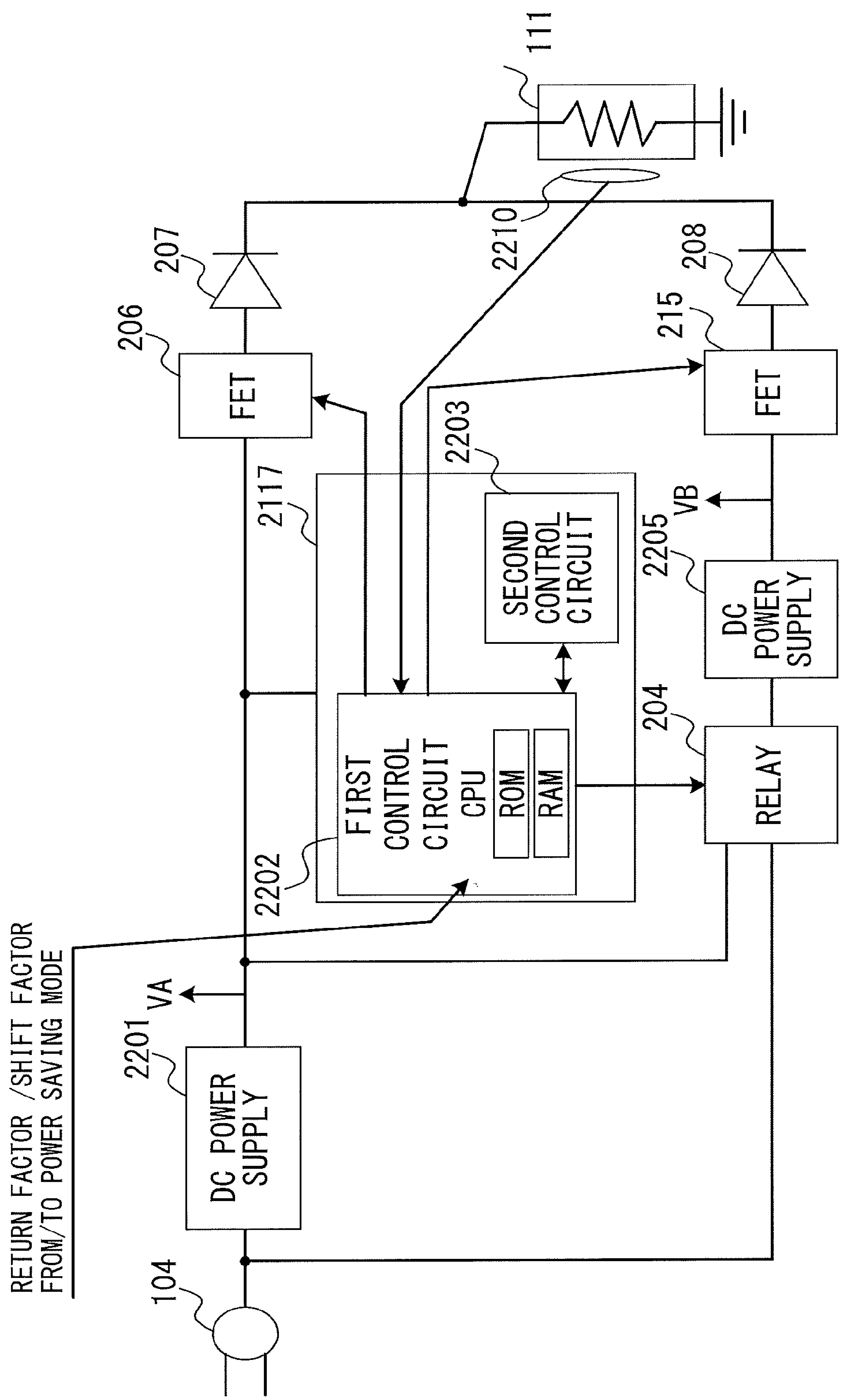

111
2210
207
206
FET
208
215
FET
2203
2117
SECOND CONTROL CIRCUIT
VB
2205
DC POWER SUPPLY
204
RELAY
FIRST CONTROL CIRCUIT
CPU
ROM
RAM
2202
RETURN FACTOR /SHIFT FACTOR FROM/TO POWER SAVING MODE
VA
2201
DC POWER SUPPLY
104

FIG. 15

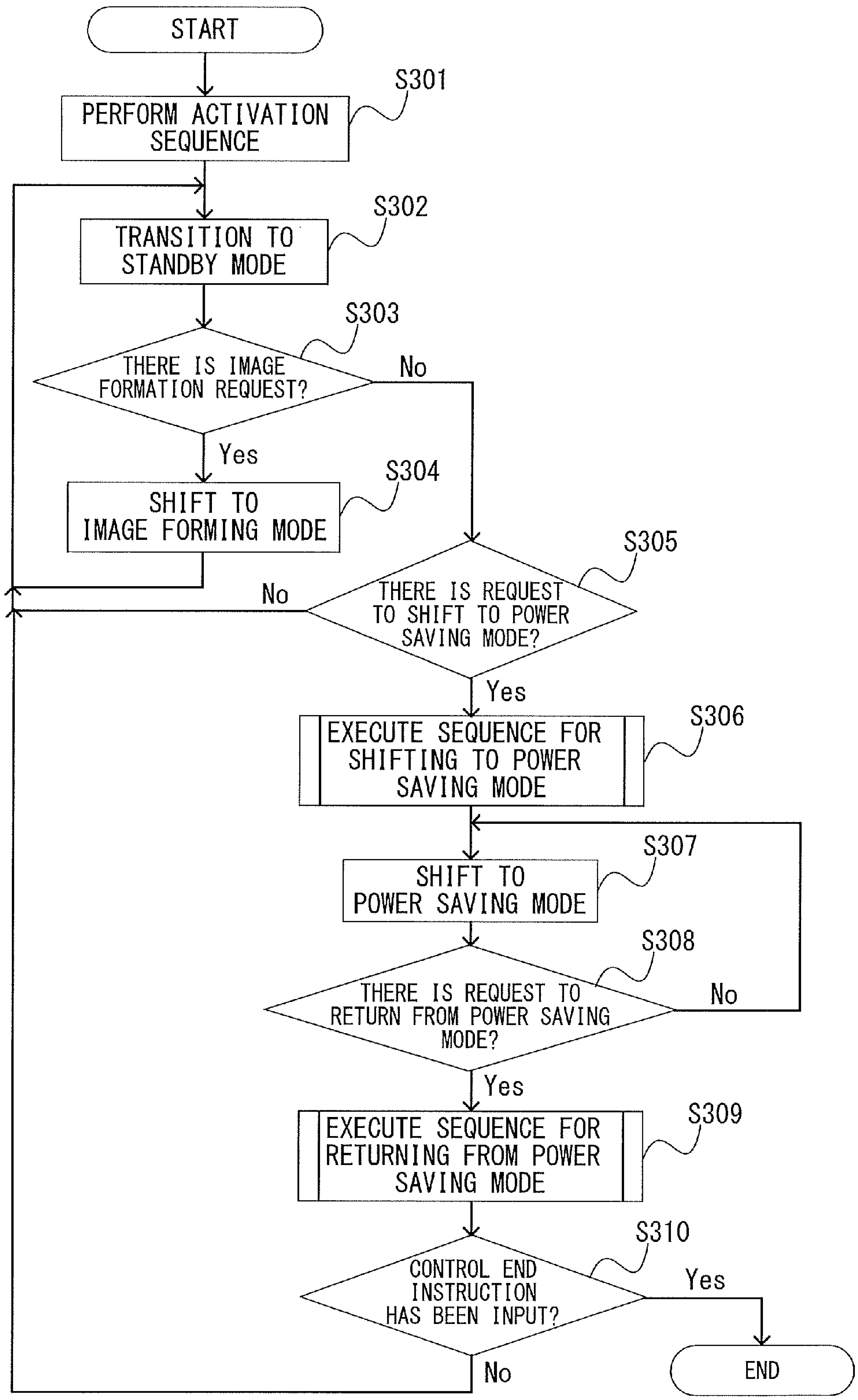

START
PERFORM ACTIVATION SEQUENCE
S301
TRANSITION TO STANDBY MODE
S302
THERE IS IMAGE FORMATION REQUEST?
S303
No
Yes
SHIFT TO IMAGE FORMING MODE
S304
THERE IS REQUEST TO SHIFT TO POWER SAVING MODE?
S305
No
Yes
EXECUTE SEQUENCE FOR SHIFTING TO POWER SAVING MODE
S306
SHIFT TO POWER SAVING MODE
S307
THERE IS REQUEST TO RETURN FROM POWER SAVING MODE?
S308
No
Yes
EXECUTE SEQUENCE FOR RETURNING FROM POWER SAVING MODE
S309
CONTROL END INSTRUCTION HAS BEEN INPUT?
S310
Yes
No
END

FIG. 16

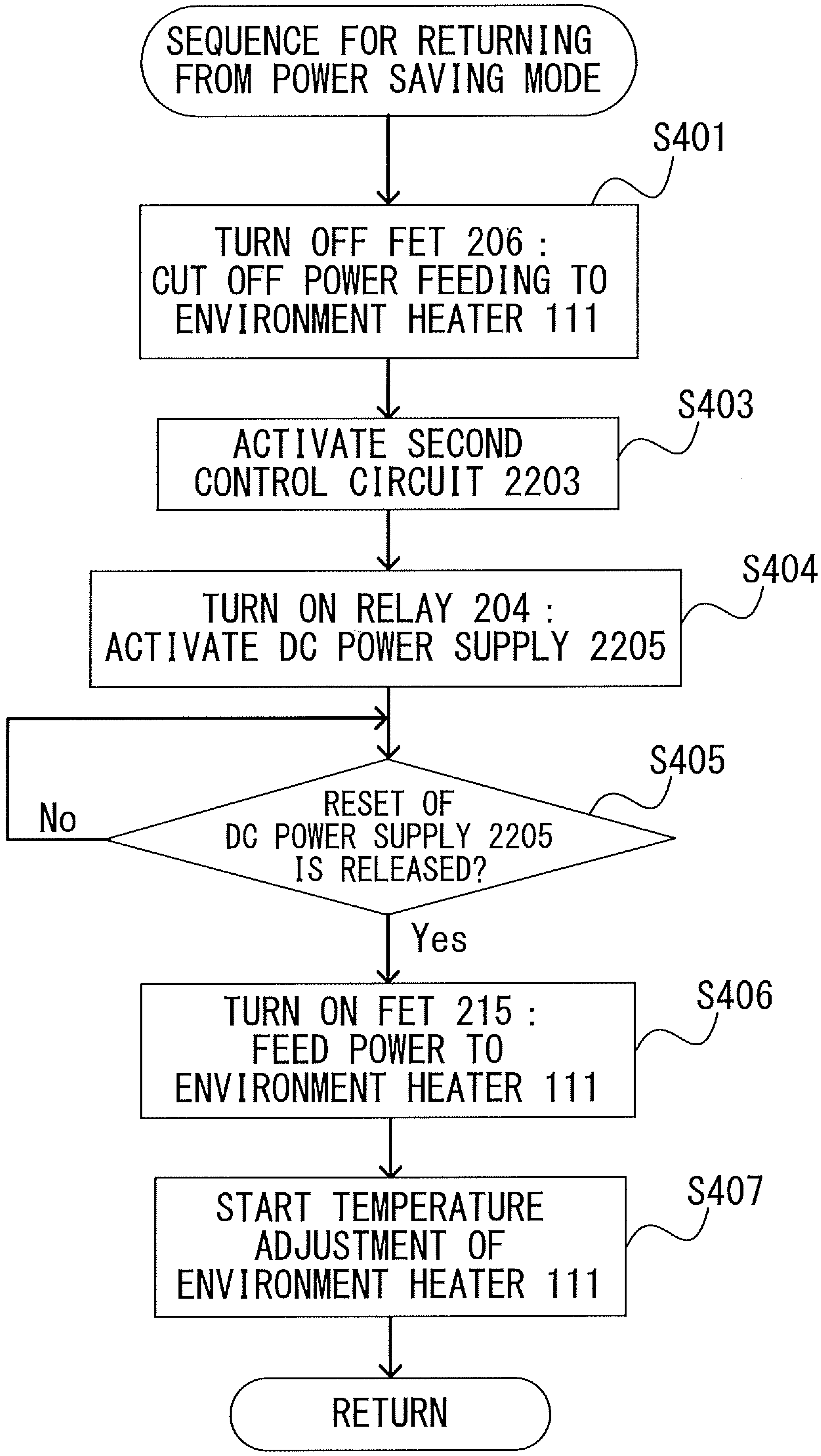

SEQUENCE FOR RETURNING FROM POWER SAVING MODE
S401
TURN OFF FET 206 : CUT OFF POWER FEEDING TO ENVIRONMENT HEATER 111
S403
ACTIVATE SECOND CONTROL CIRCUIT 2203
S404
TURN ON RELAY 204 : ACTIVATE DC POWER SUPPLY 2205
S405
RESET OF DC POWER SUPPLY 2205 IS RELEASED?
No
Yes
S406
TURN ON FET 215 : FEED POWER TO ENVIRONMENT HEATER 111
S407
START TEMPERATURE ADJUSTMENT OF ENVIRONMENT HEATER 111
RETURN

FIG. 17

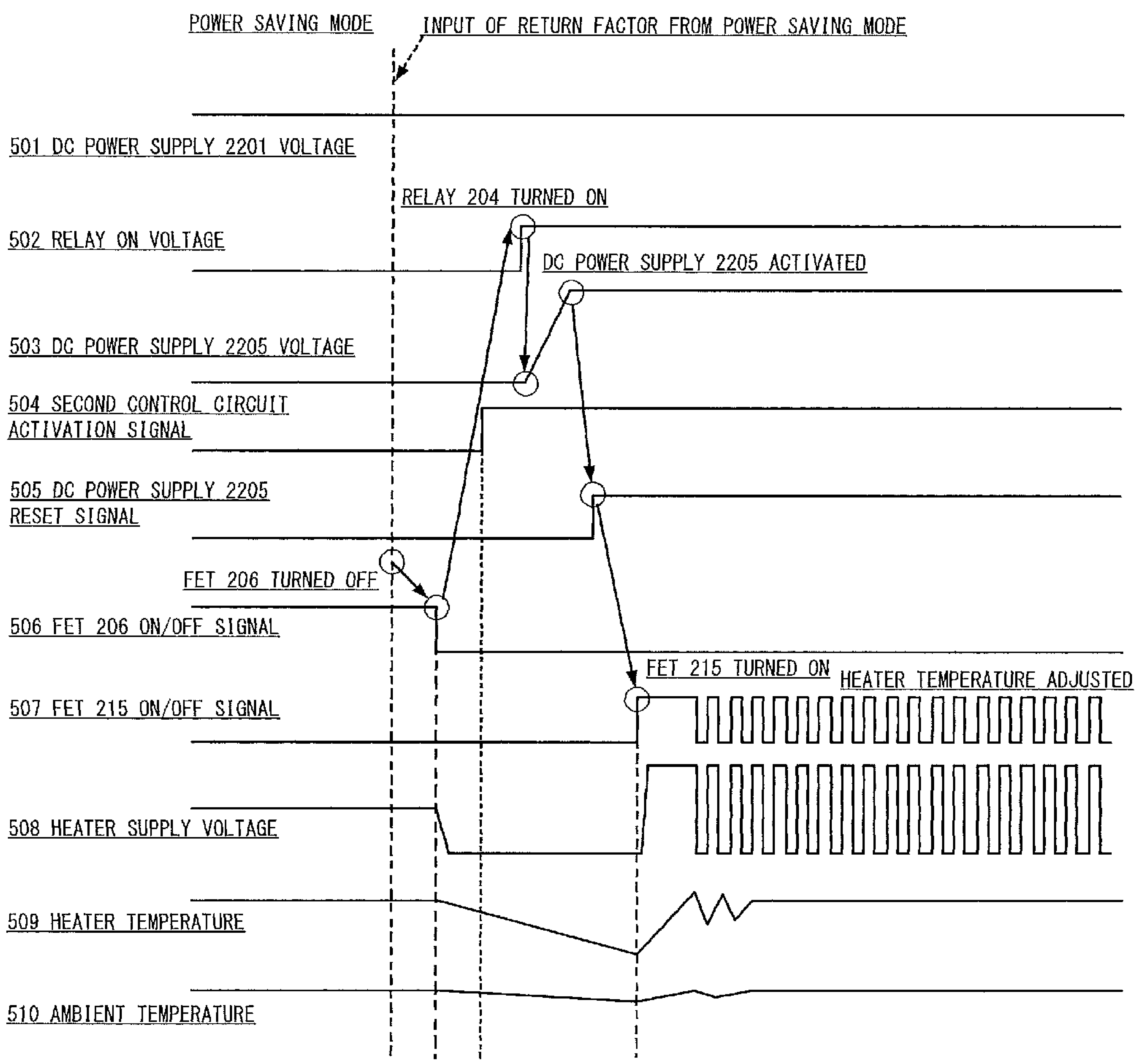

POWER SAVING MODE
INPUT OF RETURN FACTOR FROM POWER SAVING MODE
501 DC POWER SUPPLY 2201 VOLTAGE
RELAY 204 TURNED ON
502 RELAY ON VOLTAGE
DC POWER SUPPLY 2205 ACTIVATED
503 DC POWER SUPPLY 2205 VOLTAGE
504 SECOND CONTROL CIRCUIT ACTIVATION SIGNAL
505 DC POWER SUPPLY 2205 RESET SIGNAL
FET 206 TURNED OFF
506 FET 206 ON/OFF SIGNAL
FET 215 TURNED ON
HEATER TEMPERATURE ADJUSTED
507 FET 215 ON/OFF SIGNAL
508 HEATER SUPPLY VOLTAGE
509 HEATER TEMPERATURE
510 AMBIENT TEMPERATURE

FIG. 18

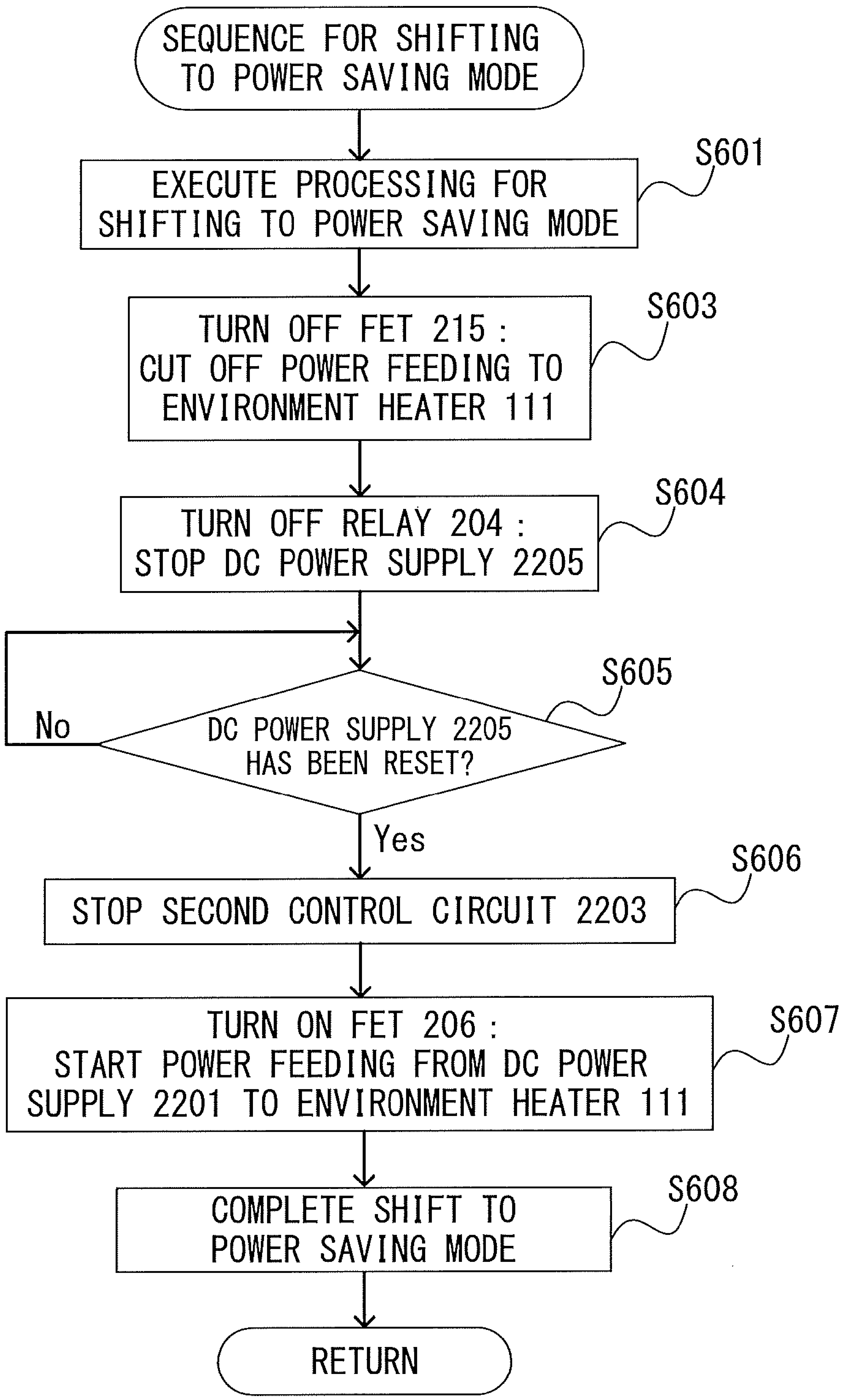

SEQUENCE FOR SHIFTING TO POWER SAVING MODE
EXECUTE PROCESSING FOR SHIFTING TO POWER SAVING MODE
S601
TURN OFF FET 215 : CUT OFF POWER FEEDING TO ENVIRONMENT HEATER 111
S603
TURN OFF RELAY 204 : STOP DC POWER SUPPLY 2205
S604
DC POWER SUPPLY 2205 HAS BEEN RESET?
S605
No
Yes
STOP SECOND CONTROL CIRCUIT 2203
S606
TURN ON FET 206 : START POWER FEEDING FROM DC POWER SUPPLY 2201 TO ENVIRONMENT HEATER 111
S607
COMPLETE SHIFT TO POWER SAVING MODE
S608
RETURN

FIG. 19

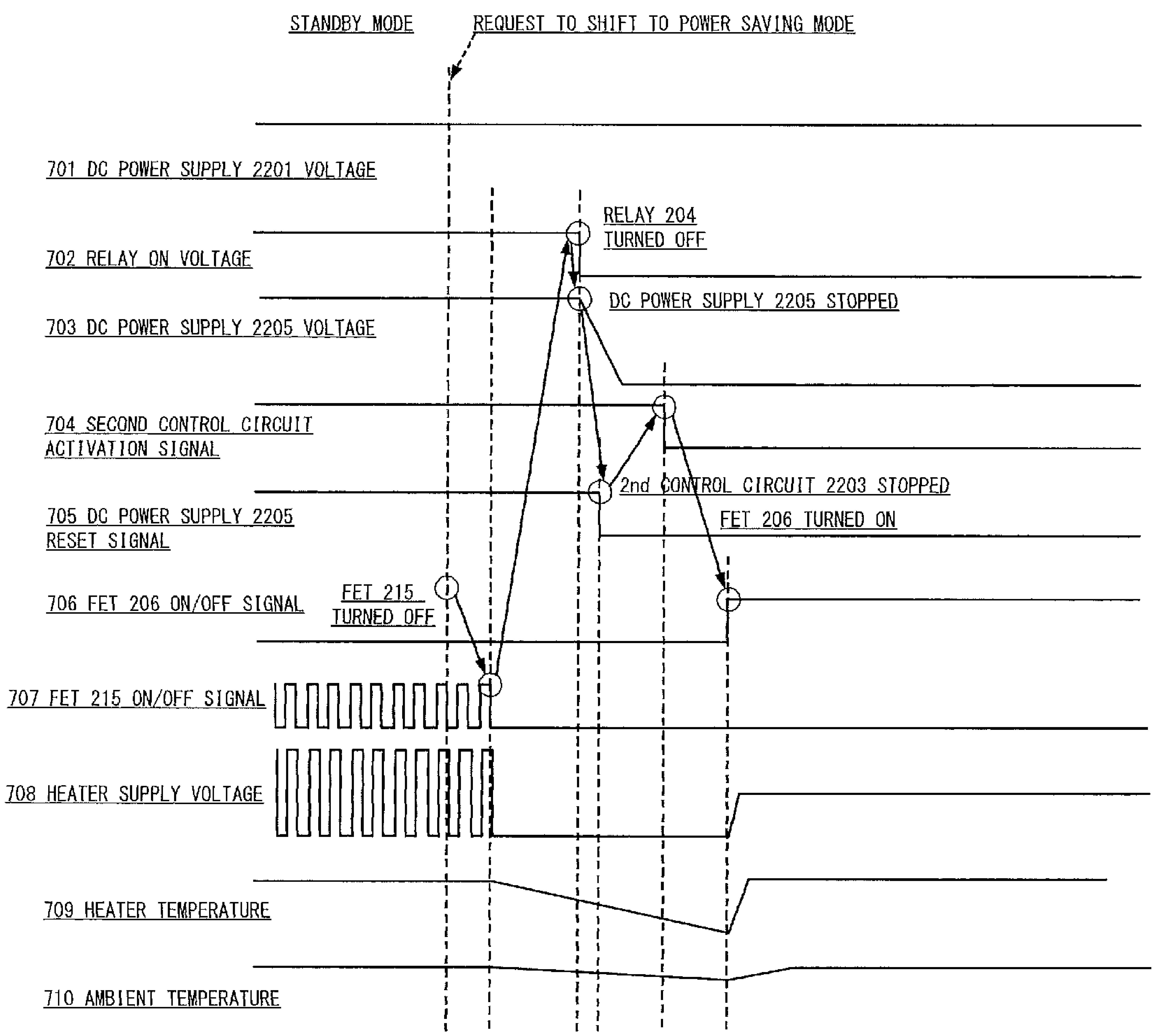

STANDBY MODE
REQUEST TO SHIFT TO POWER SAVING MODE
701 DC POWER SUPPLY 2201 VOLTAGE
702 RELAY ON VOLTAGE
RELAY 204 TURNED OFF
703 DC POWER SUPPLY 2205 VOLTAGE
DC POWER SUPPLY 2205 STOPPED
704 SECOND CONTROL CIRCUIT ACTIVATION SIGNAL
2nd CONTROL CIRCUIT 2203 STOPPED
705 DC POWER SUPPLY 2205 RESET SIGNAL
FET 206 TURNED ON
706 FET 206 ON/OFF SIGNAL
FET 215 TURNED OFF
707 FET 215 ON/OFF SIGNAL
708 HEATER SUPPLY VOLTAGE
709 HEATER TEMPERATURE
710 AMBIENT TEMPERATURE

FIG. 20

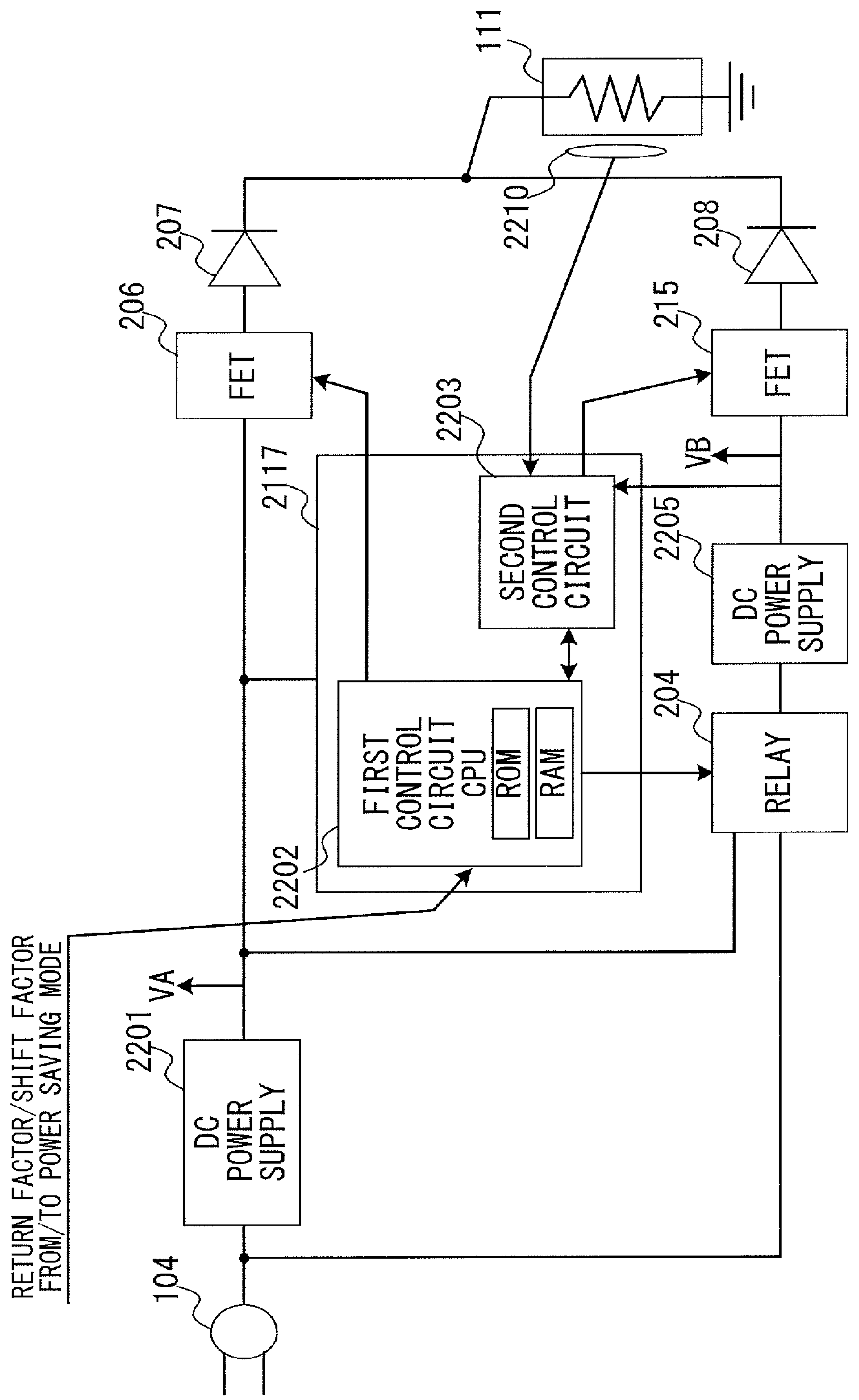

111
207
206
FET
2210
208
215
FET
2203
2117
SECOND CONTROL CIRCUIT
VB
2205
DC POWER SUPPLY
204
FIRST CONTROL CIRCUIT CPU
ROM
RAM
RELAY
2202
RETURN FACTOR/SHIFT FACTOR FROM/TO POWER SAVING MODE
VA
2201
DC POWER SUPPLY
104

FIG. 21

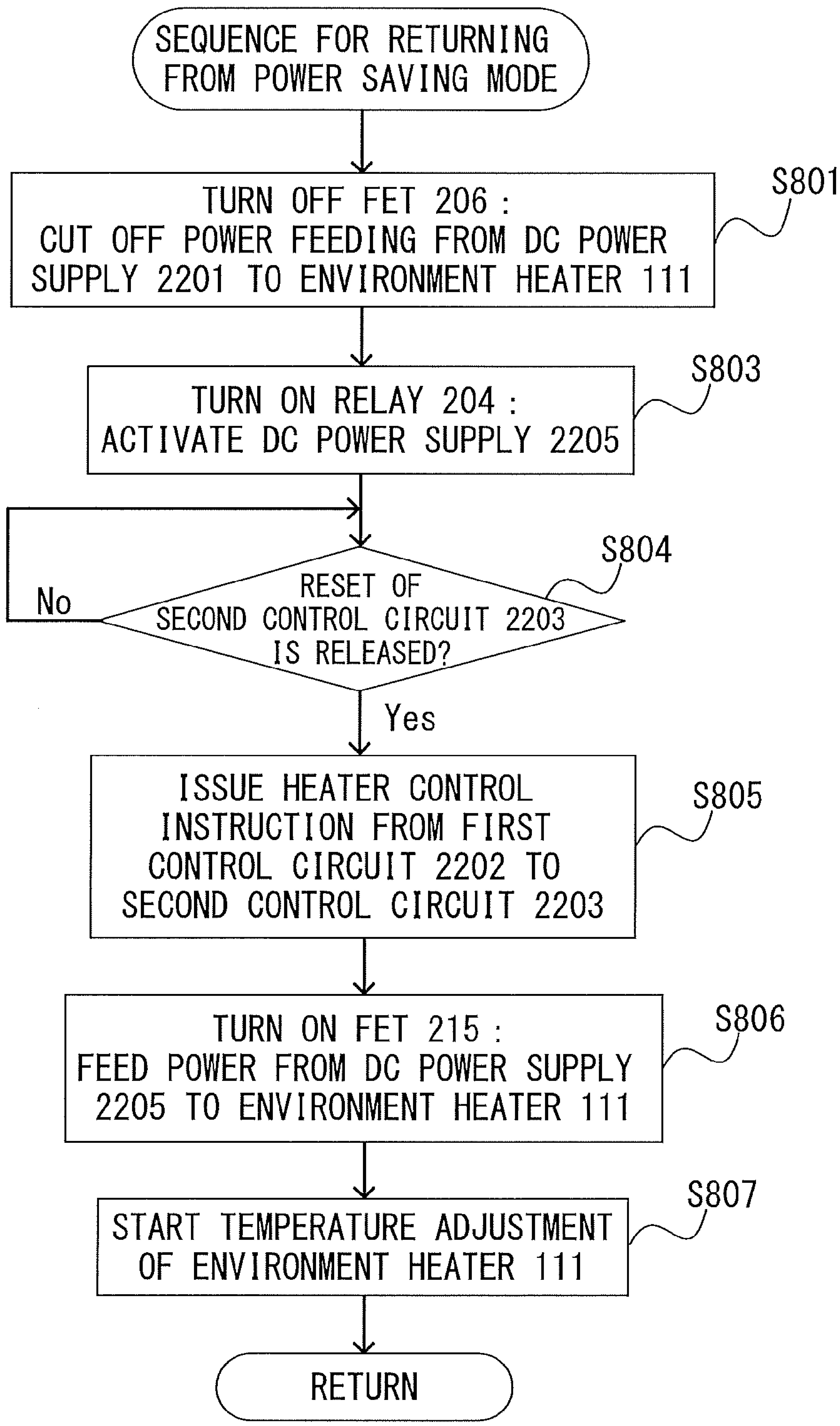

SEQUENCE FOR RETURNING FROM POWER SAVING MODE
TURN OFF FET 206 : CUT OFF POWER FEEDING FROM DC POWER SUPPLY 2201 TO ENVIRONMENT HEATER 111
S801
TURN ON RELAY 204 : ACTIVATE DC POWER SUPPLY 2205
S803
RESET OF SECOND CONTROL CIRCUIT 2203 IS RELEASED?
S804
No
Yes
ISSUE HEATER CONTROL INSTRUCTION FROM FIRST CONTROL CIRCUIT 2202 TO SECOND CONTROL CIRCUIT 2203
S805
TURN ON FET 215 : FEED POWER FROM DC POWER SUPPLY 2205 TO ENVIRONMENT HEATER 111
S806
START TEMPERATURE ADJUSTMENT OF ENVIRONMENT HEATER 111
S807
RETURN

FIG. 22

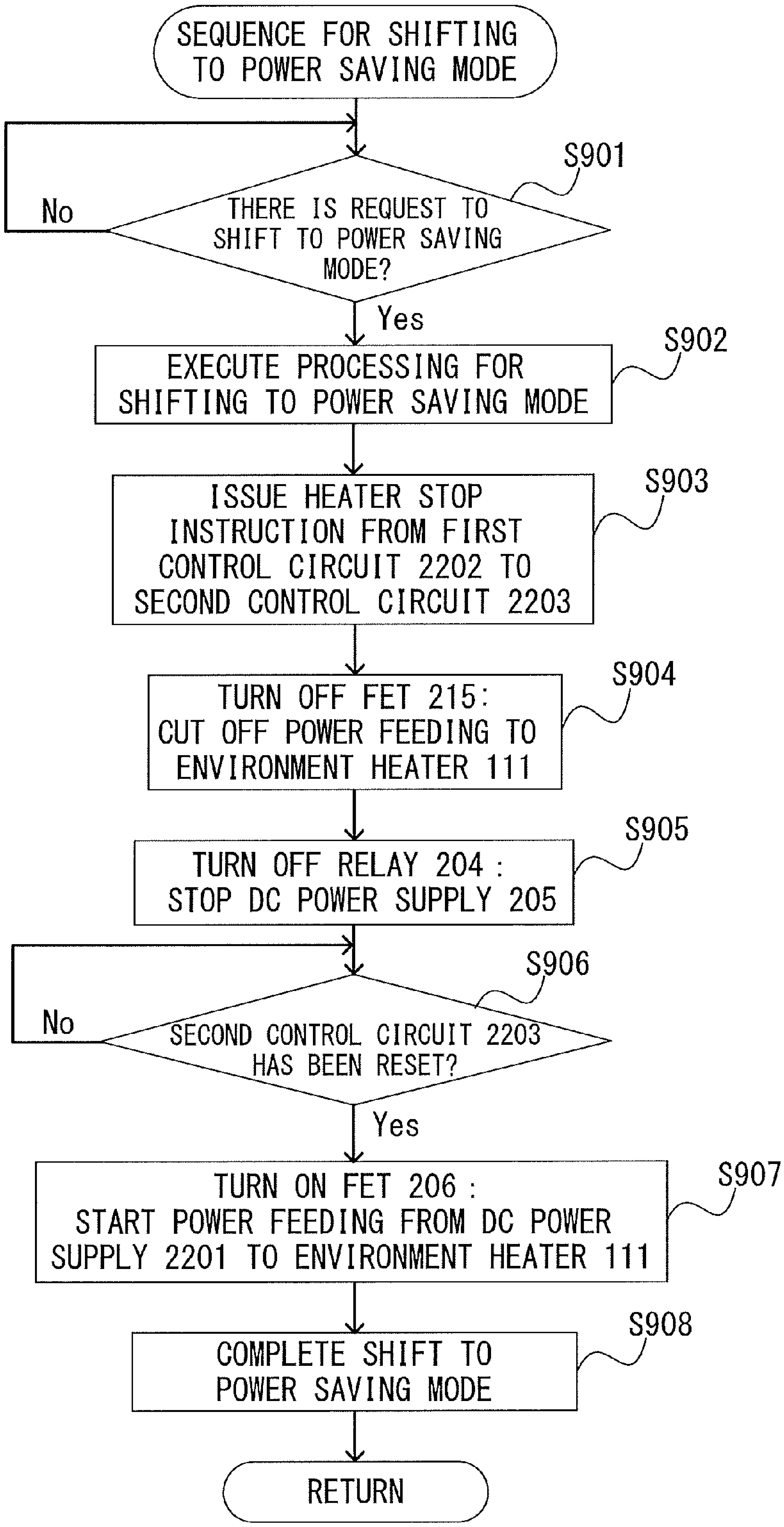

SEQUENCE FOR SHIFTING TO POWER SAVING MODE
S901
THERE IS REQUEST TO SHIFT TO POWER SAVING MODE?
No
Yes
S902
EXECUTE PROCESSING FOR SHIFTING TO POWER SAVING MODE
S903
ISSUE HEATER STOP INSTRUCTION FROM FIRST CONTROL CIRCUIT 2202 TO SECOND CONTROL CIRCUIT 2203
S904
TURN OFF FET 215: CUT OFF POWER FEEDING TO ENVIRONMENT HEATER 111
S905
TURN OFF RELAY 204 : STOP DC POWER SUPPLY 205
S906
SECOND CONTROL CIRCUIT 2203 HAS BEEN RESET?
No
Yes
S907
TURN ON FET 206 : START POWER FEEDING FROM DC POWER SUPPLY 2201 TO ENVIRONMENT HEATER 111
S908
COMPLETE SHIFT TO POWER SAVING MODE
RETURN

FIG. 23

# IMAGE FORMING APPARATUS THAT SWITCHES BETWEEN A FIRST SUPPLY MODE AND A SECOND SUPPLY MODE

## BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a technology for controlling a heater included in an image forming apparatus.

Description of the Related Art

In an image forming apparatus having an electrophotographic process, image defects may occur due to, for example, dew condensation caused by environmental fluctuation, such as coldness at night or in the morning depending on the region or season, and a rapid increase in room temperature caused by the use of an air conditioner immediately after the start of work in an office. As a result, in order to prevent dew condensation, there is known a method in which, after the image forming apparatus has been installed, dew condensation is prevented by adding a heater (hereinafter referred to as "environment heater") configured to maintain temperature at a constant level in the image forming apparatus based on the usage environment. The environment heater is installed in the image forming apparatus based on a determination by a maintenance worker or based on the needs of a user.

In recent years, image forming apparatus have been required to have more stable image quality and longer life. In order to satisfy those requirements, it is necessary to further stabilize, in an electrophotographic process, the temperature of parts around a photosensitive drum and the temperature in a cassette in which recording sheets are stored. However, the environment heater is a type of heater to which a fed AC commercial power supply is directly input. In view of this, in Japanese Patent Application Laid-open No. 2009-216827, there is proposed a configuration in which an input circuit to an AC heater is changed depending on a voltage of the AC commercial power supply, which is different in each intended market region.

In Japanese Patent Application Laid-open No. 2009-216827, there is disclosed an environment heater to be selectively mounted to an apparatus main body depending on the voltage of the AC commercial power supply to be used.

However, in the heater configured to use the AC commercial power supply, the amount of heat generated by the heater is increased as the supplied voltage is increased. Therefore, when the AC voltage supplied to the image forming apparatus varies, the amount of heat generated by the AC heater in accordance therewith also varies.

When the voltage of the commercial power supply varies depending on the region in which the image forming apparatus is installed, the amount of heat generated by the AC heater also varies, and hence it is difficult to maintain the temperature at a constant level using the AC heater. In view of this, there has been proposed usage of a DC heater configured to use DC power obtained by subjecting the AC commercial power supply to alternating current/direct current (AC/DC) conversion. The DC heater is used as the environment heater.

In particular, in an image forming apparatus having a power saving mode, power is also required to be fed to a control unit configured to control the state of the power saving mode. In order to feed power to such a control unit, there is provided a control circuit DC power supply configured to constantly output the power supply voltage.



Therefore, there have been proposed usage of the DC heater as the environment heater as described above, and also the usage of the above-mentioned control circuit DC power supply as a power supply of the environment heater.

However, with the configuration described in Japanese Patent Application Laid-open No. 2009-216827, even though measures are taken for each standard value of the voltage of the AC commercial power supply, there are no measures for dealing with variation in the voltage value. In order to tackle this issue, as the environment heater, a configuration using the DC heater may be used. When a DC power supply having an output voltage that is controlled at a constant voltage is used as the power supply for the DC heater, temperature ripples may be reduced even when there is variation in the voltage of the commercial power supply.

However, as the power supply for the DC heater, when a plurality of environment heaters are connected in parallel to a control circuit power supply configured to operate even during the power saving mode, a timing occurs in which power is simultaneously fed to the plurality of environment heaters, which causes the maximum power consumption of the control circuit power supply to increase. As a result, it is necessary to employ a high-output control circuit power supply. However, in this case, there remains a problem in that the power consumption of the image forming apparatus during the power saving mode is increased.

Further, when the DC heater is simply connected in parallel to the control circuit DC power supply as the environment heater, apart from in the power saving mode in which the environment heater is not driven, the power consumption of the control unit is increased in a standby mode or an image forming mode.

Therefore, as the DC power supply, it is necessary to employ a high-output control circuit DC power supply, which is capable of dealing with an increase in the power consumption of the DC heater, which is added to the power consumption of the control unit. However, in this case, there arises a problem in that power of the image forming apparatus during the power saving mode is increased.

In general, a control circuit DC power supply is a power supply configured to feed power to a logic circuit, typified by a central processing unit (CPU) and an application-specific integrated circuit (ASIC), and a load drive DC power supply is a power supply configured to feed power to loads such as motors and a solenoid. Therefore, the load drive DC power supply has a higher voltage than the control circuit DC power supply. When the voltage applied to the DC heater increases when switching from the control circuit DC power supply to the load drive DC power supply, power increases, which may cause abnormal heating. Further, a deviation (hereinafter referred to as "temperature ripple") from a target temperature may increase.

It is a primary object of the present invention to provide an image forming apparatus capable of suppressing an increase in power during the power saving mode.

Further, it is also an object of the present invention to perform, in the image forming apparatus, temperature control by arranging a heater, and to suppress abnormal heating and temperature ripples of the heater.

## SUMMARY OF THE INVENTION

According to the present disclosure, an image forming apparatus, which has a first power mode and a second power mode, the second power mode having a lower power consumption than the first power mode, the image forming apparatus comprises: a first power supply unit configured to operate in the first power mode and the second power mode; a second power supply unit configured not to operate in the first power mode but to operate in the second power mode; an image forming unit configured to form an image; a heater configured to heat the image forming unit; and

a controller configured to switch a power supply source to the heater from the first power supply unit to the second power supply unit based on a shift from the second power mode to the first power mode, and to switch the power supply source to the heater from the second power supply unit to the first power supply unit based on a shift from the first power mode to the second power mode.

Further features of the present invention will become apparent from the following description of exemplary embodiments (with reference to the attached drawings).

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic configuration diagram of an image forming apparatus according to an embodiment of the present invention.

FIG. **2** is a block diagram for illustrating an example of a function configuration of the image forming apparatus.

FIG. **3** is a flowchart for illustrating an operation outline of the image forming apparatus.

FIG. **4** is a flowchart for illustrating an example of a control procedure when the image forming apparatus returns from a power saving mode.

FIG. **5** is a timing chart for illustrating details of the control procedure described with reference to FIG. **4**.

FIG. **6** is a flowchart for illustrating an example of a control procedure when the image forming apparatus shifts to the power saving mode.

FIG. **7** is a timing chart for illustrating details of the control procedure described with reference to FIG. **6**.

FIG. **8** is a block diagram for illustrating an example of a function configuration of the image forming apparatus different from that illustrated in FIG. **2**.

FIG. **9**A and FIG. **9**B are timing charts for illustrating examples of configurations when a capacitor is connected in parallel to the environment heater.

FIG. **10** is a block diagram for illustrating an example of a function configuration of the image forming apparatus different from FIG. **2** and FIG. **8**.

FIG. **11** is a block diagram for illustrating an example of a function configuration of the image forming apparatus different from FIG. **2**, FIG. **8**, and FIG. **10**.

FIG. **12**A is a table for showing a status for each state (environment switch **122** is in an on state), and FIG. **12**B is a table for showing a status for each state (environment switch **122** is in an off state).

FIG. **13** is a flowchart for illustrating an example of a control procedure when the image forming apparatus shifts from the power saving mode to a standby **2** mode.

FIG. **14** is a schematic configuration diagram of the image forming apparatus according to this embodiment.

FIG. **15** is a block diagram for illustrating an example of a function configuration of the image forming apparatus.

FIG. **16** is a flowchart for illustrating an operation outline of the image forming apparatus.

FIG. **17** is a flowchart for illustrating a return operation from the power saving mode.

FIG. **18** is a flowchart for illustrating the return operation from the power saving mode.

FIG. **19** is a flowchart for illustrating processing performed when shifting to the power saving mode.

FIG. **20** is a timing chart for illustrating a shift operation to the power saving mode.

FIG. **21** is a function block diagram of an image forming apparatus according to a third embodiment of the present invention.

FIG. **22** is a flowchart for illustrating processing performed when shifting to the power saving mode in the third embodiment.

FIG. **23** is a flowchart for illustrating processing performed when shifting to the power saving mode in the third embodiment.

## DESCRIPTION OF THE EMBODIMENTS

Now, an image forming apparatus according to embodiments of the present invention is described with reference to the drawings. The image forming apparatus according to the embodiments is described as an image forming apparatus having an image forming mode and a standby mode as power modes, and a power saving mode.

The image forming mode is the power mode when performing image formation. The standby mode includes a standby **1** mode and a standby **2** mode. The standby **1** mode is the power mode for a state when an image forming operation is capable of starting. The image forming apparatus according to the embodiments is capable of connecting to an external terminal via a network.

When a usage frequency by the user is low, a supply of power to electric loads that are not necessary during the standby **1** mode may be stopped, and a network response via an external terminal may be issued. The standby **2** mode is the power mode that requires a longer time to reach a state in which image formation can be started than that for the standby **1** mode. When the image forming apparatus is not going to be used for a long time, the power saving mode is used. In the power saving mode, the supply of power for network responses is stopped, and standby power is reduced. The level of power consumption of each mode in descending order is the image forming mode, the standby **1** mode, the standby **2** mode, and the power saving mode.

### First Embodiment

FIG. **1** is a schematic configuration diagram of an image forming apparatus **100** according to a first embodiment of the present invention. In FIG. **1**, a perspective view of the image forming apparatus **100** as seen from a diagonal rear side thereof is illustrated. The image forming apparatus **100** includes an image forming apparatus main body **101**, an image reading unit **102**, and a document feeding unit **103**. The image forming apparatus main body **101** includes an image forming unit (not shown). An AC cord **104** is for drawing a commercial power supply. A plug shape of the AC cord **104** depends on the intended market. The AC commercial power supply is fed to the apparatus via the AC cord **104** and an inlet **105**.

The image forming apparatus **100** according to the first embodiment is configured to be capable of shifting from the image forming mode, which is the mode used when performing image formation or when waiting for image formation to start, or from the standby mode, to the power saving mode, which is a mode having a lower power consumption than a normal power mode. The term standby mode refers to the modes other than the power saving mode. In the following, the modes other than the power saving mode are referred to as a first mode, and the power saving mode is referred to as a second mode.

A main body power supply **118** includes a first power supply (e.g., a constant power supply unit serving as a first power supply unit) **201**, which is configured to operate in the power saving mode, and a second power supply (e.g., a non-constant power supply unit serving as a second power supply unit) **205**, which is configured to operate in the modes other than the power saving mode. The details of those units are described later with reference to FIG. **2**.

The first power supply **201** and the second power supply **205** are DC power supply units configured to output a DC power supply when an AC commercial power supply is supplied. The output DC power supplies are supplied to drive loads (not shown), such as a system controller **117**, various types of motors, and a solenoid, via a relay board **116** serving as a power supply distributing unit. Therefore, the first power supply **201** and the second power supply **205** serve as a power supply source for the system controller **117**, for example.

The system controller **117** includes a CPU, a read-only memory (ROM) into which control programs and the like are written, and a work random-access memory (RAM) for performing processing. In the system controller **117**, a non-volatile memory (not shown) for storing data even when the image forming apparatus **100** is turned off, and an input/output (I/O) port (not shown), for example, are connected to various constituent devices via an address bus and a data bus.

The I/O port is connected to drive loads (not shown), such as motors and the solenoid, a sensor (not shown) configured to detect a conveyance position of a recording sheet on which an image is to be formed, a fixing device (not shown), and the like. The CPU is configured to execute an image forming operation by controlling successive inputs and outputs via the I/O port based on the content of the ROM.

A network port **232** is a communication port configured to be used when an instruction to perform an image forming operation or another operation is issued to the image forming apparatus **100** via an external terminal (not shown). Communication between each terminal and the image forming apparatus **100** is performed under the control of the system controller **117** via the network port **232**.

A power mode switching switch **123** is a switch for instructing a switch in the power mode, for example, a shift from a mode other than the power saving mode (first mode) to the power saving mode (second mode) (hereinafter referred to as "shift to the power saving mode"). The power mode switching switch **123** is also a switch for instructing a shift from the power saving mode to a mode other than the power saving mode (hereinafter referred to as "return from the power saving mode"). The power modes relating to the operation of the image forming apparatus **100** can be switched by the user pressing the power mode switching switch **123**.

A main switch **230** is a switch that is manually operated in order to turn on and off the power supply of the image forming apparatus **100**.

An environment heater **111** is arranged near a sheet feeding cassette **124** in which the recording sheets are stored. The environment heater **111**, which is configured as a DC heater, is a resistor having a predetermined resistance value Rh, for example. The power of the environment heater **111** and the amount of heat generated by the environment heater **111** are determined based on the supplied direct voltage. Power feeding control to the environment heater **111** is performed so that power is fed only when an environment switch **122** is in an on state. The environment switch **122**, which is manually operated by the user, is configured to function as a switch for switching whether or not power can be fed to the environment heater **111**.

In the first embodiment, the environment heater **111** is arranged near the sheet feeding cassette **124** in which the recording sheets are stored. However, the environment heater **111** may be arranged at another position. For example, the environment heater **111** may be arranged near the image forming unit including a photosensitive member and other such parts.

FIG. **2** is a block diagram for illustrating an example of a function configuration of the image forming apparatus **100**.

The first power supply **201** is configured to supply power when the image forming apparatus **100** is connected to a commercial power supply outlet via the AC cord **104**. Power is supplied to the system controller **117** via the first power supply **201**.

The system controller **117** includes a control circuit A **202** configured to operate even during the power saving mode, and a control circuit B **203** configured to operate in the modes other than the power saving mode but not operate in the power saving mode.

The control circuit A **202** in the system controller **117** is configured to function as a type of computer including a CPU, a ROM in which control programs for controlling various types of processing are stored, and a RAM serving as a system work memory to be used in order to execute the various kinds of processing.

The control circuit A **202** is configured to drive, when a shift factor signal from a mode other than the power saving mode to the power saving mode, or a return factor signal from the power saving mode to a mode other than the power saving mode has been input, a field-effect transistor (FET) **209** based on that shift instruction or return instruction. As a result, the control circuit A **202** is configured to control activation and stopping of the control circuit B **203**. The control circuit A **202** is also capable of controlling activation and stopping of the second power supply **205** by driving a relay **204**. Further, the control circuit A **202** is capable of controlling power feeding to the environment heater **111**, and cutting off of such power feeding, by driving an FET **206**.

Examples of the shift factor from a mode other than the power saving mode to the power saving mode may include, in addition to the above-mentioned pressing of the power mode switching switch **123**, image formation not being performed for a fixed length of time. Examples of the return factor from the power saving mode to a mode other than the power saving mode may include, in addition to the above-mentioned pressing of the power mode switching switch **123**, a request for a connection confirmation response from an externally-connected device and an image formation request.

Power is fed to the environment heater **111** along a first power feeding path and a second power feeding path. In the first power feeding path, a voltage VA from the first power supply **201** is supplied from the FET **206**, which is driven by the control circuit A **202**, via a diode **207**. In the second power feeding path, a voltage VB from the second power supply **205** is supplied via a diode **208**.

The second power supply **205** is connected to the drive loads necessary for an image reading operation and an image forming operation, detection elements, and the control unit (not shown) for controlling those elements.

FIG. **3** is a flowchart for illustrating an operation outline of the image forming apparatus **100**. The control processing of the image forming apparatus **100** is mainly performed by the system controller **117**.

When power feeding by the AC commercial power supply starts, the image forming apparatus **100** performs activation sequences for executing various types of processing, such as activation of the first power supply **201** and the second power supply **205**, confirmation of the state of the image forming apparatus **100**, and various types of adjustments (Step S**301**). Then, the image forming apparatus **100** transitions the state to the standby mode (Step S**302**).

When the image forming apparatus **100** has received an image formation request from an external terminal (not shown) or the like (Step S**303**: Yes), the image forming apparatus **100** shifts to the image forming mode and performs an image forming operation (Step S**304**). After the image forming operation has ended, the image forming apparatus **100** again shifts to the standby mode.

When there has not been an image formation request (Step S**303**: No), the image forming apparatus **100** determines whether or not there is a request to shift to the power saving mode (Step S**305**).

When a shift factor signal to the power saving mode has been input by, for example, pressing the power mode switching switch **123** (Step S**305**: Yes), the image forming apparatus **100** executes a sequence for shifting to the power saving mode (Step S**306**). In the sequence for shifting to the power saving mode, the image forming apparatus **100** executes processing for stopping the drive loads (not shown), such as the motors and the solenoid, the control circuit B **203**, and the second power supply **205**. Then, the image forming apparatus **100** shifts to the power saving mode (Step S**307**).

The image forming apparatus **100** determines whether or not there is a return factor from the power saving mode such as, for example, pressing of the power mode switching switch **123** (Step S**308**). When a return factor signal from the power saving mode has been input by, for example, pressing the power mode switching switch **123** (Step S**308**: Yes), the image forming apparatus **100** executes a sequence for returning from the power saving mode (Step S**309**). In the sequence for returning from the power saving mode, the image forming apparatus **100** executes processing for activating the drive loads (not shown), such as the motors and the solenoid, the control circuit B **203**, and the second power supply **205**. Then, the image forming apparatus **100** determines whether or not a control end instruction has been input (Step S**310**). When the control end instruction has been input (Step S**310**: Yes), the image forming apparatus **100** ends the processing. When the control end instruction has not been input (Step S**310**: No), the image forming apparatus **100** shifts to the standby mode (Step S**302**).

When it is determined that there is no return factor from the power saving mode (Step S**308**: No), the image forming apparatus **100** determines whether or not there is a shift factor to the standby **2** mode such as, for example, a network response request from an external terminal connected to the network (Step S**311**). When a shift factor signal to the standby **2** mode has been input (Step S**311**: Yes), the image forming apparatus **100** executes a sequence for shifting to the standby **2** mode (Step S**312**). The details of the sequence for shifting to the standby **2** mode are described later. The image forming apparatus **100** then shifts to the standby **2** mode (Step S**313**).

When it is determined that there is no shift factor to the standby **2** mode (Step S**311**: No), the image forming apparatus **100** returns the processing to Step S**306**. In this case, the image forming apparatus **100** shifts to the power saving mode.

The image forming apparatus **100** determines whether or not there is a shift factor to the power saving mode, such as a predetermined time having elapsed since the shift to the standby **2** mode (Step S**314**). When it is determined that there is a shift factor to the power saving mode, such as the predetermined time having elapsed (Step S**314**: Yes), the image forming apparatus **100** executes the sequence for shifting to the power saving mode (Step S**306**). When it is determined that there is no such shift factor (Step S**314**: No), the image forming apparatus **100** returns the processing to Step S**313**. In this case, the image forming apparatus **100** maintains the standby **2** mode.

The details of the processing performed in Step S**309** illustrated in FIG. **3** (sequence for returning from the power saving mode) are now described with reference to FIG. **2** and to the control flowchart illustrated in FIG. **4**.

FIG. **4** is a flowchart for illustrating an example of a control procedure when the image forming apparatus **100** returns from the power saving mode. Each of the following control processing steps is mainly performed by the control circuit A **202**.

When a return factor from the power saving mode has been input to the image forming apparatus **100**, the control circuit A **202** turns off (OFF) the FET **206** to cut off power feeding from the first power supply **201** to the environment heater **111** (Step S**401**). More specifically, when a return factor from the power saving mode has been input, the control circuit A **202** outputs a signal sig. A **221**, which sets a voltage level to low (L), to an AND circuit **212**. When one of two inputs to the AND circuit **212** is an L signal, output from the AND circuit **212** is uniquely determined to be an L signal. As a result, output from the AND circuit **212** to which the signal sig. A **221** has been input becomes an L signal, and the FET **206** is turned off.

After power feeding is cut off, the control circuit A **202** waits until a predetermined time (e.g., 100 [ms]) has elapsed (Step S**402**). After the predetermined time has elapsed, the control circuit A **202** turns on (ON) the FET **209** to activate the control circuit B **203** (Step S**403**). More specifically, the control circuit A **202** outputs a signal sig. C **223**, which sets the voltage level to high (H), to the AND circuit **212** to turn on the FET **209**.

The control circuit A **202** then turns on (ON) the relay **204** to activate the second power supply **205** (Step S**404**). More specifically, the control circuit A **202** outputs a signal sig. B **222** to turn on the relay **204** via a diode **213**. When the activation of the second power supply **205** is complete and the activation of the loads necessary for the image forming operation has been confirmed, the control circuit A **202** shifts the image forming apparatus **100** to the standby mode (Step S**405**).

Thus, when the image forming apparatus **100** returns from the power saving mode to the standby mode, the control circuit B **203** may be activated without increasing the power consumption of the first power supply **201**, and power feeding to the environment heater **111** may be switched from the first power supply **201** to the second power supply **205**.

The operations performed on the first power supply **201** side and the operations performed on the second power supply **205** side relating to the state of the environment switch **122** are now described.

On the first power supply **201** side, when the environment switch **122** is in an on state, an H signal is input to the AND circuit **212**, which is arranged upstream of the FET **206**. Further, output from the AND circuit **212** is determined based on the voltage level of the signal sig. A **221**. When the environment switch **122** is in an off state, an output from the

AND circuit **212** is an L signal regardless of the voltage level of the signal sig. A **221**, and hence the FET **206** is stopped.

On the second power supply **205** side, when the environment switch **122** is in an on state, an H signal is input to an AND circuit **217**, and a signal sig. D **224**, which is an output signal from the AND circuit **217**, is similarly determined based on the voltage level of the signal sig. A **221**.

Because a NOT circuit **218** is arranged on the upstream side of the AND circuit **217**, output from the AND circuit **217** has an exclusive relation with output from the AND circuit **212** described above. Output from the AND circuit **217** is input to the relay **204** via a diode **214**, and a determination is made to activate the second power supply **205**. When the environment switch **122** is in an off state, the signal sig. D **224** is an L signal. As long as the image forming apparatus **100** is not in the standby mode, namely, as long as the signal sig. B **222** is not an H signal, the relay **204** is turned off, and hence the second power supply **205** is not activated.

The switching of the environment switch **122** determines whether or not an FET **215**, which is arranged downstream from the second power supply **205**, is turned on or off. During the standby mode, during which the signal sig. B **222** is an H signal, the relay **204** is turned on to activate the second power supply **205**. In the standby mode, when the environment switch **122** is in an off state, power feeding to the environment heater **111** is cut off by the FET **215**. In the following description, unless noted otherwise, the environment switch **122** is in an on state.

The details of the processing performed in Step S**312** illustrated in FIG. **3** (sequence for shifting from power saving mode to standby **2** mode) are now described with reference to FIG. **2** and to the control flowchart illustrated in FIG. **13**.

FIG. **13** is a flowchart for illustrating an example of a control procedure when the image forming apparatus **100** shifts from the power saving mode to the standby **2** mode. Each of the following control processing steps is mainly performed by the control circuit A **202**.

The control circuit A **202** starts the sequence for shifting to the standby **2** mode (shift processing) when a network response request has been input to the image forming apparatus **100** from an external terminal connected to the network (Step S**701**).

The control circuit A **202** cuts off power feeding from the first power supply **201** to the environment heater **111** by setting the signal sig. A **221** to an L signal, which causes an output from the AND circuit **212** to be an L signal, thereby stopping the FET **206**. The control circuit A **202** also inputs the signal sig. A **221** to the NOT circuit **218** and the AND circuit **217**. As a result, the signal sig. D **224**, which is the output signal from the AND circuit **217**, becomes an H signal, the relay **204** is turned on, and the second power supply **205** is activated (Step S**702**). Then, the control circuit A **202** shifts to the standby **2** mode (Step S**703**).

Thus, in the standby **2** mode, power feeding to the environment heater **111** switches from the first power supply **201** to the second power supply **205**. During the standby **2** mode, the system controller **117** is driven in order to handle the network response. As a result, when power continues to be fed from the first power supply **201** as is, the necessary power level can no longer be met. Therefore, during the standby **2** mode, the power supply source of the environment heater **111** is switched to the second power supply **205**. In this case, when the environment switch **122** is in an off state, an L signal is input to the AND circuit **217**, the signal sig. D **224** becomes an L signal, the relay **204** is turned off, and the second power supply **205** is stopped.

The relations among the various above-mentioned output signals (signal sig. A **221** and the like) from the control circuit A **202** in each mode of the image forming apparatus **100** and the states of the first power supply **201**, the second power supply **205**, the control circuit B **203**, and the environment heater **111** are now described with reference to FIG. **12**A and FIG. **12**B.

FIG. **12**A and FIG. **12**B are tables for showing the status of each constituent device in each mode. In FIG. **12**A and FIG. **12**B, the state of the main switch **230** and each mode are shown on the vertical axis, and the states of each output signal, the first power supply **201**, the second power supply **205**, the control circuit B **203**, and the environment heater **111** are shown on the horizontal axis. In FIG. **12**A, a case is shown in which the environment switch **122** is in an on state and the environment heater **111** is activated. In FIG. **12**B, a case is shown in which the environment switch **122** is in an off state and the environment heater **111** is stopped.

In each mode, the state of the environment heater **111** is switched based on whether the environment switch **122** is in an on state or an off state. When the environment switch **122** is in an on state, the environment heater **111** is in a heat-generating state.

The case when the environment switch **122** is in anon state is now described. When the main switch **230** is turned off under a state in which the AC commercial power supply is being supplied by the AC cord **104**, and when the image forming apparatus **100** is in the power saving mode, the first power supply **201** is operating, and power is fed to the environment heater **111** by the first power supply **201**. When the image forming apparatus **100** is in the standby **2** mode, and when the image forming apparatus **100** is in the standby mode or the image forming mode, namely, when the image forming apparatus **100** is in a mode other than the power saving mode, power is fed to the environment heater **111** by the second power supply **205**.

When the image forming apparatus **100** is in the standby mode or the image forming mode, the second power supply **205** feeds power to the environment heater **111** as well as to each load in the image forming apparatus **100**. In contrast, when the image forming apparatus **100** is in the standby **2** mode, because only the network response is operating, the image forming apparatus **100** is controlled so that power is fed only to the environment heater **111**. As a result, when the environment heater **111** is not to be used, it is necessary to turnoff the environment switch **122** in order to prevent the second power supply **205** from being unnecessarily activated.

In the image forming apparatus **100** according to the first embodiment, during the standby **2** mode, the signal sig. D **224** may be switched between an H signal and an L signal based on whether the environment switch **122** is in an on state or an off state, and the relay **204** and the second power supply **205** may also be switched between being on or off.

Activation of the relay **204** is executed when the signal sig. D **224** is an H signal. Therefore, it is necessary for the signal sig. A **221** to be an H signal and the environment switch **122** to be in an on state. During the standby mode and the image forming mode, the signals sig. A **221**, sig. B **222**, sig. C **223**, and sig. D **224** are each an H signal, the first power supply **201**, the second power supply **205**, and the control circuit B **203** are activated, and power is fed to the environment heater **111** from the second power supply **205**.

The case when the environment switch **122** is in an off state is now described. In such a case, the environment heater **111** is in a stopped state in each mode. The states of the signal sig. A **221** to signal sig. D **224**, the first power supply **201**, the second power supply **205**, and the control circuit B **203** are, other than in the standby **2** mode, the same as when the environment switch **122** is an on state. As described above, in the case of the standby **2** mode, the signal sig. D **224** is set to L to stop the relay **204** in order to prevent the second power supply **205** from being unnecessarily activated.

FIG. **5** is a timing chart for illustrating the details of the control procedure described with reference to FIG. **4**.

A first row (**1**) on the vertical axis of the timing chart illustrated in FIG. **5** is the voltage VA [V] (rated output voltage value V**1**−Vd **207**) of the first power supply **201**, and a second row (**2**) is a power consumption W_whole [W] of the first power supply **201**. A third row (**3**) on the vertical axis is a total power consumption W_circuit [W] of the control circuit A **202** and the control circuit B **203**, and a fourth row (**4**) is the voltage VB [V] (rated output voltage value V**2**−Vd **208**) of the second power supply **205**. A fifth row (**5**) on the vertical axis is a power consumption W_heat [W] of the environment heater **111**.

When the image forming apparatus **100** is in the power saving mode, each of the rows (**1**) to (**5**) in the timing chart illustrated in FIG. **5** is in the following state.

The voltage ((**1**)) of the first power supply **201** is VA=V**1**−Vd **207** [V], the power consumption ((**2**)) of the first power supply **201** is W_whole=W_circuit A+Wh**1** [W], and the power consumption ((**3**)) of the control circuits is W_circuit=W_circuit A[W]. The voltage ((**4**)) of the second power supply **205** is VB=0 [V], and the power consumption ((**5**)) of the environment heater **111** is W_heat=VA**2**/Rh.

In this case, the voltage V**1** is the rated output voltage value of the first power supply **201**, the W_circuit A is the power consumption value of the control circuit A **202**, the W_circuit B is the power consumption value of the control circuit B **203**, and the Rh is the resistance value of the environment heater **111**. The power consumption Wh**1** is the power consumption value of the environment heater **111** when the voltage VA of the first power supply **201** is in a supplied state, and the power consumption Wh**2** is the power consumption value of the environment heater **111** when the voltage VB of the second power supply **205** is in a supplied state. In the first embodiment, to simplify the description, a voltage drop of the FETs **206**, **209**, and **215**, the diodes **213** and **214**, the NOT circuit **218**, and the AND circuits **212** and **217** is 0 [V].

When the voltage drop of the diode **207** is Vd **207** and the voltage drop of the diode **208** is Vd **208**, Vd **207**<Vd **208**. Further, V**1**−Vd **207**=V**2**−Vd **208**.

The control circuit A **202** of the image forming apparatus **100** turns off the FET **206** by setting the signal sig. A **221** to an L signal based on an input of a return factor from the power saving mode indicated on the horizontal axis of FIG. **5** (refer to the processing in Step S**401**). As a result, the power consumption ((**2**)) W_whole of the first power supply **201** starts to drop as illustrated in FIG. **5** due to a decrease in the power consumption Wh**1** of the environment heater **111**.

At a timing after waiting for a predetermined time (refer to the processing in Step S**402**), there is no longer any effect of the power consumption Wh**1** from the power consumption ((**2**)) W_whole of the first power supply **201**. Then, the control circuit A **202** sets the signal sig. B **222** to an H signal to turn on the FET **209** (refer to the processing in Step S**403**). As a result, the control circuit B **203** is activated, and the power consumption ((**2**)) W_whole of the first power supply **201** starts to increase, as illustrated in FIG. **5**.



As a result, the power consumption W_circuit B of the control circuit B **203** is added, and the power consumption ((**2**)) W_whole of the first power supply **201** becomes the total of the power consumption W_circuit A of the control circuit A **202** and the power consumption W_circuit B of the control circuit B **203**.

Thus, the image forming apparatus **100** is controlled so that cutting off of power feeding from the first power supply **201** to the environment heater **111** is started, and after cut off is complete, the control circuit B **203** is activated. As a result, the power consumption W_whole of the first power supply **201** does not have a period in which the power consumption W_circuit B of the control circuit B **203** overlaps the power consumption Wh**1** of the environment heater **111**.

Further, in the image forming apparatus **100**, the second power supply **205** is activated by turning on the relay **204** last, and power feeding to the environment heater **111** is started together with the resultant voltage increase (VB from 0). As a result, the environment heater **111** is in a state consuming W_heat=Wh**2**=VB**2**/Rh power.

At this stage, based on the fact that V**1**−Vd **207**=V**2**−Vd **208**, Wh**1**=Wh**2**. Because there is no change to the heater temperature even when the power supply of the environment heater **111** is switched, it is necessary that Wh**1**=Wh**2**. In the description of the first embodiment, Wh**1**=Wh**2** is established due to the voltage drop of the diodes. However, the configuration of this feature is not limited, and may also be achieved by, for example, a voltage-dividing circuit.

For example, when switching of the power feeding path to the environment heater **111** is not controlled in synchronization with input of a return factor and a shift factor from the power saving mode, the low-output type first power supply **201** continues to feed power to the environment heater **111** as is. In other words, the control circuit B **203** performs a normal mode operation while the first power supply **201** continues to feed power to the environment heater **111** as is. In this case, the power needed by the environment heater **111** cannot be fully met by the first power supply **201**, causing a voltage drop to occur, thereby giving rise to a problem in that operation of the image forming apparatus **100** becomes unstable.

A case is now described in which switching of the power feeding path to the environment heater **111** is not controlled in consideration of the time taken to drive/stop the FET **206** and the time taken to drive/stop the FET **209**, namely, in consideration of drive completion. In this case, there is a timing at which power feeding to the environment heater **111** during a mode shift and the normal mode operation of the control circuit B **203** overlap, which causes the same problem as described above to occur.

When a high-output type first power supply **201** is employed, the above-mentioned problem does not occur, but during the power saving mode, the image forming apparatus **100** operates in a region in which the power efficiency of the first power supply **201** is low during the power saving mode. As a result, power loss by the first power supply **201** increases, causing the power consumption of the image forming apparatus **100** during the power saving mode to increase.

The details of the processing performed in Step S**306** illustrated in FIG. **3** (sequence for shifting from standby mode to power saving mode) are now described with reference to the control flowchart illustrated in FIG. **6**.

FIG. **6** is a flowchart for illustrating an example of the control procedure when the image forming apparatus **100** shifts to the power saving mode. Each of the following control processing steps is mainly performed by the control circuit A **202**.

When a shift factor to the power saving mode is input when the image forming apparatus **100** is in the standby mode, the control circuit A **202** starts shift processing (Step S**601**). Further, processing such as backing-up necessary data is executed.

The control circuit A **202** turns off (OFF) the relay **204** to cut off the AC commercial power supply to the second power supply **205** (Step S**602**). More specifically, after the shift processing has ended, the control circuit A **202** sets the signal sig. B **222** to an L signal, meaning that an L signal is input to the diode **213**. The control circuit A **202** also sets the signal sig. A **221** to an H signal, meaning that an H signal is input to the NOT circuit **218** and the AND circuit **217**. As a result, the signal sig. D **224** becomes an L signal, meaning that an L signal is input to the diode **214**. Therefore, because inputs to the diodes **213** and **214** are both L signals, the relay **204** is turned off.

The control circuit A **202** turns off (OFF) the FET **209** to stop operation of the control circuit B **203** (Step S**603**). The control circuit A **202** waits for a predetermined time (e.g., 100 [ms]) (Step S**604**), and then turns on (ON) the FET **206** to enable (turn on) the power feeding path from the first power supply **201** to the environment heater **111** (Step S**605**). More specifically, the control circuit A **202** turns on the FET **206** by controlling so that output from the AND circuit **212** is an H signal by setting the signal sig. A **221** to an H signal. Then, the image forming apparatus **100** shifts to the power saving mode (Step S**606**).

The details of the control procedure described with reference to FIG. **6** are now described with reference to the timing chart illustrated in FIG. **7**.

FIG. **7** is a timing chart for illustrating the details of the control procedure described with reference to FIG. **6**. The vertical axis (each row) of the timing chart illustrated in FIG. **6** is the same as that in FIG. **5**, and hence a description thereof is omitted here.

When the image forming apparatus **100** is in the standby mode, each of the rows (**1**) to (**5**) in the timing chart illustrated in FIG. **7** are in the following state.

The voltage ((**1**)) of the first power supply **201** is VA=V**1**−Vd **207** [V], and the power consumption ((**2**)) of the first power supply **201** is W_whole=W_circuit A+W_circuit B[W]. The power consumption ((**3**)) of the control circuits is W_circuit=W_circuit A+W_circuit B [W]. The voltage ((**4**)) of the second power supply **205** is VB=V**2**−Vd**208** [V], and the power consumption ((**5**)) of the environment heater **111** is W_heat=VB**2**/Rh.

The control circuit A **202** of the image forming apparatus **100** executes, based on input of a shift factor to the power saving mode indicated on the horizontal axis of FIG. **7**, shift processing under a state in which operation of the control circuit A **202** and operation of the control circuit B **203** are maintained (refer to the processing in Step S**601**). The power consumption ((**3**)) of the control circuits at this stage is power consumption W_circuit=W_circuit A+W_circuit B [W].

The control circuit A **202** turns off the relay **204** by setting the signal sig. B **222** to an L signal (refer to the processing in Step S**602**). Through performing this step, the AC commercial power supply to the second power supply **205** is cut off. As a result, as illustrated in FIG. **7**, the voltage ((**4**)) of the second power supply **205** starts to drop from the voltage V**2**.



The control circuit A **202** stops operation of the control circuit B **203** by setting the signal sig. C **223** to an L signal to turn off the FET **209** (refer to the processing in Step S**603**). As a result, the power consumption ((**3**)) W_circuit of the control circuits starts to decrease by the amount of power consumption of the power consumption W_circuit B of the control circuit B **203**. Therefore, the power consumption ((**3**)) W_circuit of the control circuits after a predetermined time has elapsed (refer to the processing in Step S**604**) is only the power consumption W_circuit A of the control circuit A **202**.

The control circuit A **202** enables the power feeding path from the first power supply **201** to the environment heater **111** by setting the signal sig. A **221** to an H signal to turn on the FET **206** (refer to the processing in Step S**605**). As a result, power is supplied from the first power supply **201** to the environment heater **111**, and the power consumption ((**2**)) W_whole of the first power supply **201** is in a state in which the power consumption W_heat of the control circuit A **202** and the environment heater **111** is equal to VA**2**/Rh (refer to the processing in Step S**307**).

Thus, in the image forming apparatus **100**, there is a timing at which power feeding to the environment heater **111** is cut off when returning from the power saving mode and when shifting from the standby mode to the power saving mode.

However, because the cut-off duration is short, the effect on the temperature of the parts near the sheet feeding cassette **124** of the recording sheets (or image forming unit (not shown)) is small.

The control operations (exclusive control operations by the FETs) performed by the control circuit A **202** relating to each of the processing steps in Steps S**401** to S**403** illustrated in FIG. **4** and the processing steps in Steps S**603** to S**605** illustrated in FIG. **6** may also be implemented by a hardware circuit illustrated in FIG. **8**.

FIG. **8** is a block diagram for illustrating an example of a function configuration of the image forming apparatus **100** different from that illustrated in FIG. **2**.

In the function configuration of the image forming apparatus **100** illustrated in FIG. **8**, the drive signal from the control circuit A **202** is connected to the FET **209** via a delay circuit **281**. The drive signal is also connected to the FET **206** via a NOT circuit **283** and a delay circuit **282**. The delay circuits **281** and **282** are designed such that a rising delay time increases from after an input signal becomes an H signal until an output signal becomes an H signal. The delay circuits **281** and **282** are also designed such that a falling delay time from after the input signal becomes an L signal until the output signal becomes an L signal is zero, or is sufficiently smaller than the rising delay time.

The point that each of the processing steps may be implemented even by a hardware circuit is now described with reference to FIG. **9**A and FIG. **9**B.

FIG. **9**A and FIG. **9**B are timing charts for illustrating examples of configurations when a capacitor is connected in parallel to the environment heater **111**. First, the point that each of the processing steps of Steps S**401** to S**403** (sequence for returning from power saving mode) illustrated in FIG. **4** can be implemented by using the hardware circuit illustrated in FIG. **8** is now described with reference to the timing chart of FIG. **9**A.

The first row (**1**) on the vertical axis of the timing chart illustrated in FIG. **9**A is a signal output of the control circuit

A 202, the second row (2) is the signal output of the delay circuit 281 (i.e., power feeding state of FET 209), the third row (3) is the signal output of the NOT circuit 283, and the fourth row (4) is the signal output of the delay circuit 282 (i.e., power feeding state of FET 206).

At a timing T1 indicated in FIG. 9A, when the control circuit A 202 sets the off control of the FET 206 illustrated in FIG. 4 (refer to the processing in Step S401), namely, sets the signal sig. A 221 to an H signal, an H signal is input to the NOT circuit 283.

The NOT circuit 283 inverts the input signal, and outputs an L signal to the delay circuit 282. After the falling delay time, the delay circuit 282 outputs an L signal to the FET 206 at a timing T2 to turn off the FET 206. In synchronization with this control, an H signal (signal sig. A 221 is set to an H signal) is input to the delay circuit 281 at the timing T1. The delay circuit 281 receives the H signal, and then after the rising delay time has elapsed (corresponding to the processing in Step S402), turns on the FET 209 at a timing T3 (refer to the processing in Step S403).

Next, the point that each of the processing steps of Steps S603 to S605 (sequence for shifting to power saving mode) illustrated in FIG. 6 can be implemented by using the hardware circuit illustrated in FIG. 8 is now described with reference to the timing chart of FIG. 9B. The vertical axis of FIG. 9B has the same configuration as the vertical axis of FIG. 9A, and hence a description thereof is omitted here.

At a timing T4 indicated in FIG. 9B, when the control circuit A 202 sets the off control of the FET 209 illustrated in FIG. 6 (refer to the processing in Step S603), namely, sets the signal sig. A 221 to an L signal, an L signal is input to the delay circuit 281. The delay circuit 281 receives the L signal, and after the falling delay time, outputs the L signal to the FET 209 at a timing T5 to turn off the FET 209. In synchronization with this control, an L signal (signal sig. A 221 is set to an L signal) is input to the NOT circuit 283 at the timing T4. The NOT circuit 283 inverts the input signal, and outputs an H signal to the delay circuit 282.

The delay circuit 282 outputs an H signal to the FET 206 at a timing T6 after the rising delay time (corresponding to the processing in Step S604) to turn on the FET 206 (refer to the processing in Step S605).

The hardware circuit illustrated in FIG. 8 is described as a circuit in which the FET 206 and the FET 209 are driven by H signals. In addition to such a configuration, as a circuit configured to drive the FETs by L logic, the circuit may instead be designed so that the control circuit A 202 and the delay circuit 281 are connected via the NOT circuit 283, and the control circuit A 202 and the delay circuit 282 are directly connected.

Further, as a circuit configured to drive the FETs by L logic, the circuit may instead be designed so that the control logic of the control circuit A 202 when shifting modes is the opposite to that described above, and the relationship between the rising delay time and the falling delay time of the delay circuits is also the opposite to that described above.

In addition, the control circuit A 202 is described in the first embodiment by using a CPU, but the control circuit A 202 may also be configured from a hardware circuit configured to drive the FET 206 and the relay 204 by synchronizing the return factor signal and the shift factor signal from the power saving mode with the input signal.

FIG. 10 is a block diagram for illustrating an example of a function configuration of the image forming apparatus 100 different from FIG. 2 and FIG. 8.

As illustrated in FIG. 10, when a capacitor 210 having a predetermined capacitance is connected in parallel to the environment heater 111, power can be fed to the environment heater 111 from charge accumulated in a capacitor (capacitive load) 210 even at a timing immediately after switching of the first and second power supplies. As a result, as illustrated in a timing chart, because a decrease in the power consumption can be moderated, a decrease in the amount of heat generation can be suppressed.

FIG. 11 is a block diagram for illustrating an example of a function configuration of the image forming apparatus 100 different from FIG. 2, FIG. 8, and FIG. 10.

As illustrated in FIG. 11, a current detection circuit 291 configured to detect a consumption current of the first power supply 201 is arranged on the power supply path of the first power supply 201 as a return factor from the power saving mode. A circuit configuration in which the FET 206 and the relay 204 are driven when a detection signal (detection value) of the current detection circuit 291 is a predetermined value or more may also be employed.

Thus, with the image forming apparatus 100 according to the first embodiment, power feeding to the environment heater (DC heater) 111 during the power saving mode is performed from the first power supply (constant power supply) 201, and the power feeding path from the first power supply 201 is cut off when shifting to a mode other than the power saving mode. During modes other than the power saving mode, power feeding to the environment heater 111 is performed from the second power supply (non-constant power supply) 205. As a result, an increase in power during the power saving mode can be suppressed. In other words, even when using a DC heater (direct current heater) as the environment heater 111, a low-output power supply can be used as the first power supply 201, and the power consumption amount during the power saving mode can be suppressed.

## Second Embodiment

FIG. 14 is a schematic configuration diagram of an image forming apparatus 2100 according to a second embodiment of the present invention. In FIG. 14, a perspective view of the image forming apparatus 2100 as seen from a diagonal rear side thereof is illustrated. In the image forming apparatus 2100, a system controller 2117 includes, similar to the system controller 117 illustrated in FIG. 1, a CPU, a ROM into which control programs and the like are written, and a work RAM for performing processing. In the system controller 2117, a non-volatile memory (not shown) for storing data even when the image forming apparatus 2100 is turned off, and an I/O port (not shown), for example, are connected to various constituent devices via an address bus and a data bus.

A main body power supply 2118 includes a control circuit DC power supply 2201, which is configured to operate in the power saving mode and during the normal power mode, and a load drive DC power supply 2205, which is configured to operate in the modes other than the power saving mode. The DC power supply 2201 and the DC power supply 2205 are configured to operate as direct current power supplies outputting a direct current. In order to simplify the drawings, the DC power supply 2201 and the DC power supply 2205 are only illustrated in FIG. 15, which is described later, and are not illustrated in FIG. 14. The main body power supply 2118 is described in more detail later with reference to FIG. 15. Unless noted otherwise, other parts in the image forming apparatus 2100 illustrated in FIG. 14 are similar to those of the image forming apparatus 100 illustrated in FIG. 1 of the first embodiment.

The system controller **2117** is configured to control the DC power supply **2205** so that the DC power supply **2205** does not operate in the power saving mode, but does operate in other modes. The system controller **2117** is also configured to control the DC power supply **2201** so that the DC power supply **2201** operates in the power saving mode.

FIG. **15** is a block diagram for illustrating an example of the function configuration of the image forming apparatus **2100**. As illustrated in FIG. **15**, when the plug of the AC cord **104** is connected to a commercial outlet, power is supplied to the DC power supply **2201** connected to the system controller **2117**. The AC cord **104** is configured to supply power to the DC power supply **2205** via the relay **204**. The DC power supply **2201** is connected to the environment switch **122**, the FETs **206** and **209**, and the relay **204**.

As illustrated in FIG. **15**, the system controller **2117** includes a first control circuit **2202** configured to operate in the normal power mode and the power saving mode, and a second control circuit **2203** configured not to operate in the power saving mode but to operate in the other modes.

The first control circuit **2202** in the system controller **2117** is configured to function as a type of computer including a CPU, a ROM in which control programs for controlling various types of processing are stored, and a RAM serving as a system work memory to be used in order to execute the various kinds of processing. The second control circuit **2203** is similarly configured, but in order to simplify the drawings, the CPU, the ROM, and the RAM are not illustrated. The environment heater **111** includes a temperature sensor **210** configured to detect temperature, which allows an ambient temperature around the environment heater **111** to be detected. The ambient temperature detected by the temperature sensor **210** is transmitted to the first control circuit **2202**. The first control circuit **2202** is configured to refer to the transmitted ambient temperature, and to control the temperature of the environment heater **111** by controlling ON/OFF of the FET **206** or the FET **215**.

The DC power supply **2205** is connected to drive loads, such as the motors and the solenoid, necessary for the image reading operation and the image forming operation, detection elements, and the control unit (not shown) configured to control those elements. The second control circuit **2203** is configured to control those drive loads.

Power feeding to the environment heater **111** is performed via a first power feeding path and a second power feeding path. The first power feeding path is a path for the DC power supply **2201** to feed power from the FET **206** to the environment heater **111** via the diode **207**. The second power feeding path is a path for the DC power supply **2205** to feed power to the environment heater **111** via the diode **208**.

When the request signal for shifting to the power saving mode or the request signal for returning from the power saving mode is input from the mode switching switch **123**, the system controller **2117** performs the following operations through the CPU **131** of the first control circuit **2202** depending on the input signal.

(1) Activation of the second control circuit **2203** and stop control

(2) Activation of the DC power supply **2205** by driving the relay **204** and stop control

(3) Power feeding to the environment heater **111** from the DC power supply **2201** by driving the FET **206** and cut-off control

(4) Power feeding to the environment heater **111** from the DC power supply **2205** by driving the FET **215** and cut-off control

As the request to return from the power saving mode and the request to shift to the power saving mode, in addition to the above-mentioned pressing of the mode switching switch **123**, there is an image formation request from an externally connected device and the like.

In this embodiment, power feeding of Items (3) and (4) is possible only when the environment switch **122** is in an on state. Further, even when the environment switch **122** is absent, the first control circuit can also control the energization state to the environment heater **111**, to thereby always set the environment heater to a non-power feeding state.

Next, an outline of the processing executed by the system controller **2117** of the image forming apparatus **2100** is described with reference to the control flowchart illustrated in FIG. **16**. Unless noted otherwise, each processing step in the flowchart is executed by the system controller **2117** via the CPU **131**.

When power feeding to the image forming apparatus **2100** via the AC cord **104** by the AC commercial power supply starts, power is supplied from the DC power supply **2201** to the system controller **2117**.

The CPU **131** of the system controller **2117** performs activation sequences for executing various types of processing, such as activation of the DC power supply **2205**, confirming the state of the image forming apparatus **2100**, and various types of adjustments (Step S**301**), and then transitions the state to the normal power mode (Step S**302**). Then, the CPU **131** determines whether or not there is an image formation request from an externally connected device, the image reading unit **102**, or other such devices (Step S**303**).

When there is an image formation request (Step S**303**: Yes), the CPU **131** performs an image forming operation (Step S**304**), and again shifts to the normal power mode of Step S**302**. When there is no image formation request (Step S**303**: No), the CPU **131** determines whether or not a request to shift to the power saving mode has been input by, for example, pressing the power mode switching switch **123** (Step S**305**).

When it is determined that there is no shift request (Step S**305**: No), the CPU **131** again executes Step S**302**. When it is determined that there is a shift request (Step S**305**: Yes), the CPU **131** performs a sequence, which is described later, for shifting to the power saving mode (Step S**306**), and then transitions the state to the power saving mode (Step S**307**).

Then, the CPU **131** determines whether or not a request to return from the power saving mode has been input by, for example, pressing the power mode switching switch **123** (Step S**308**). When a return request has not been input (Step S**308**: No), the CPU **131** again executes Step S**307**. When a return request has been input (Step S**308**: Yes), the CPU **131** executes a sequence, which is described later, for returning from the power saving mode (Step S**309**). The CPU **131** then determines whether or not a control end instruction has been input (Step S**310**). When there has been a control end instruction (Step S**310**: Yes), the CPU **131** ends the processing. When there is no control end instruction (Step S**310**: No), the CPU **131** again executes Step S**302**.

Next, the sequence for returning from the power saving mode illustrated in Step S**309** of FIG. **16**, and operation of the first control circuit **2202** during that sequence, are described based on the control flowchart illustrated in FIG. **17**.

After it is determined in Step S**308** of FIG. **16** that a request to return from the power saving mode has been input (Step S**308**: Yes), the CPU **131** turns off the FET **206** to cut off power feeding from the DC power supply **2201** to the environment heater **111** (Step S**401**). The CPU **131** activates the second control circuit **2203** (Step S**403**), and turns on the relay **204** to activate the DC power supply **2205** (Step S**404**).

The CPU **131** determines whether or not release of a reset signal by the DC power supply **2205** has been detected (Step S**405**). When the reset signal is not released (Step S**405**: No), this means that the DC power supply **2205** is not activated, and hence the CPU **131** again executes Step S**405**. When it is determined that the reset signal has been released and the DC power supply **2205** is activated (Step S**405**: Yes), the CPU **131** turns on the FET **215** (Step S**406**) to start power feeding to the environment heater **111**. Then, the CPU **131** performs, based on a detection result of the temperature sensor **210**, temperature adjustment control so that a target temperature of the environment heater **111** is maintained (Step S**407**).

Next, the operations performed in the image forming apparatus **2100** are described with reference to the timing chart of FIG. **18**, which is for illustrating a return operation from the power saving mode. In FIG. **18**, a DC power supply **2201** voltage **501**, a relay ON voltage **502**, a load drive DC power supply **2205** voltage **503**, a second control circuit activation signal **504**, a DC power supply **2205** reset signal **505**, and a FET **206** ON/OFF signal **506** are illustrated. Further, a FET **215** ON/OFF signal **507**, a heater supply voltage **508**, a heater temperature **509**, and an ambient temperature **510** are also illustrated in FIG. **18**.

During the power saving mode, when a request to return from the power saving mode is input to the image forming apparatus **2100** (corresponding to Step S**401** of FIG. **17**), the value of the FET **206** ON/OFF signal **506** changes from high to low, and the FET **206** is turned off.

When the FET **206** is turned off, power feeding from the DC power supply **2201** to the environment heater **111** is cut off (corresponding to Step S**401** of FIG. **17**), and the value of the heater supply voltage **508** supplied to the environment heater **111** becomes zero. Together with this, the temperature of the environment heater **111** indicated by the heater temperature **509** also decreases.

The ambient temperature of the temperature control object of the environment heater **111** does not abruptly change in response to a temperature change of the environment heater **111**. Therefore, the ambient temperature **510** gradually decreases as illustrated in FIG. **18**. In other words, by the time that power is again supplied to the environment heater **111**, the temperature does not decrease to a level that causes problems in the operation of the image forming apparatus **2100**.

On the other hand, after the value of the FET **206** ON/OFF signal **506** changes to low, the value of the second control circuit activation signal **504** changes to high, and the second control circuit **2203** is activated (corresponding to Step S**403** of FIG. **17**). As a result, the relay ON voltage **502** changes to high, the relay **204** is turned on, and AC power is supplied to the DC power supply **2205**. When the load drive DC power supply **2205** voltage **503** reaches a predetermined supply voltage, the DC power supply **2205** is activated (corresponding to Step S**404** of FIG. **17**).

When the value of the DC power supply **2205** reset signal **505** changes from low to high, the DC power supply **2205** reset signal **505** is released (corresponding to Step S**405**: Yes in FIG. **17**), the value of the FET **215** ON/OFF signal **507** changes to high, and the FET **215** is turned on. As a result, power feeding to the environment heater **111** is started (corresponding to Step S**406**).

Then, based on the detection result of the temperature sensor **210**, the FET **215** ON/OFF signal **507** is turned on/off at an appropriate timing so that the ambient temperature around the environment heater **111** is a desired temperature, and temperature adjustment control is executed (corresponding to Step S**407**). Thus, in the normal power mode, control for repeatedly turning on and off the FET **215** is performed. In that control, the power needed by the circuit to execute the control is more than in the control for simply switching elements, such as the FETs **206** and **208**, from off to on and maintaining the on state.

The DC power supply **2205** supplied to the environment heater **111** is turned ON/OFF based on the turning ON/OFF of the FET **215**, as indicated by the heater supply voltage **508**. Together with that, the heater temperature **509** of the environment heater **111** also increases, and the temperature is stabilized by temperature adjustment control.

In this manner, the ambient temperature around the temperature control object of the environment heater **111** reaches the target temperature, and is maintained at the target temperature.

Next, the power of the environment heater **111** is described. A supply voltage from the DC power supply **2201** is represented by VA, a supply voltage from the DC power supply **2205** is represented by VB, and a resistance of the environment heater **111** is represented by Rh. When VA=5 V, VB=24 V, and Rh=5Ω, the power of the environment heater **111** is calculated as follows.

1) Power Wha of the environment heater **111** during power feeding from the DC power supply **2201**

$$\begin{aligned} Wha &= (VA/Rh)\times VA \\ &= (5\ \mathrm{V}/5\Omega)\times 5\ \mathrm{V} \\ &= 5\ \mathrm{W} \end{aligned}$$

2) Power Whb of the environment heater **111** during power feeding from the DC power supply **2205**

$$\begin{aligned} Whb &= (VB/Rh)\times VB \\ &= (24\ \mathrm{V}/5\Omega)\times 24\ \mathrm{V} \\ &= 115.2\ \mathrm{W} \end{aligned}$$

Therefore, when Step S**407** of FIG. **17** is not executed, the power of the environment heater **111** becomes very large, and if left in that state, the environment heater **111** may cause a rapid temperature increase. This embodiment is effective in preventing such rapid increase. Further, in this embodiment, appropriate temperature control of the environment heater **111** may be performed even in modes other than the power saving mode.

Next, the operation illustrated in Step S**306** of FIG. **16** of the image forming apparatus **2100** when shifting from the normal power mode to the power saving mode is described with reference to the control flowchart illustrated in FIG. **19**.

After it is determined in Step S**305** of FIG. **16** that there is a request to shift to the power saving mode (Step S**305**: Yes), the CPU **131** executes processing for shifting to the power saving mode by the first control circuit **2202** (Step S**601**). In the processing for shifting to the power saving mode, processing, e.g., backing up of the data necessary during operation, is performed. When the processing for shifting to the power saving mode ends, the CPU **131** turns off the FET **215** to stop power feeding from the DC power supply **2205** to the environment heater **111** (Step S**603**).

Next, the CPU **131** turns off the relay **204** to cut off the AC supply to the DC power supply **2205** (Step S**604**), and determines whether or not the DC power supply **2205** has been reset (Step S**605**). When the DC power supply **2205** has not been reset (Step S**605**: No), Step S**605** is executed again. When the DC power supply **2205** has been reset (Step S**605**: Yes), the CPU **131** stops the second control circuit **2203** (Step S**606**). The CPU **131** turns on the FET **206** (Step S**607**) to enable the power feeding path from the DC power supply **2201** to the environment heater **111**, and then completes the shift to the power saving mode (Step S**608**).

The processing executed by the image forming apparatus **2100** is now described with reference to the timing chart illustrated in FIG. **20**. In FIG. **20**, a DC power supply **2201** voltage **701**, a relay ON voltage **702**, a load drive DC power supply **2205** voltage **703**, a second control circuit activation signal **704**, a DC power supply **2205** reset signal **705**, and a FET **206** ON/OFF signal **706** are illustrated. Further, a FET **215** ON/OFF signal **707**, a heater supply voltage **708**, a heater temperature **709**, and an ambient temperature **710** are also illustrated in FIG. **20**.

In FIG. **20**, when a request to shift to the power saving mode is input to the system controller **2117** in a mode other than the power saving mode and executed (corresponding to Step S**601** of FIG. **19**), the FET **215** ON/OFF signal **707** is turned off. As a result, power feeding from the DC power supply **2205** to the environment heater **111** is stopped (corresponding to Step S**603** of FIG. **19**), and as indicated by the heater supply voltage **708**, the supply voltage to the environment heater **111** becomes zero. The value of the FET **206** ON/OFF signal **706** changes from high to low, and the FET **206** is turned off.

When the FET **206** is turned off, power feeding from the DC power supply **2201** to the environment heater **111** is cut off (corresponding to Step S**401** of FIG. **17**), and the value of the heater supply voltage **708** supplied to the environment heater **111** becomes zero. Together with that, the temperature of the environment heater **111** indicated by the heater temperature **709** also decreases.

In this embodiment, the temperature control object of the environment heater **111** is inside a recording media storage unit or is the image forming unit. The ambient temperature of the temperature control object does not abruptly change in response to a temperature change of the environment heater **111**. Therefore, the ambient temperature **710** gradually decreases as illustrated in FIG. **20**. In other words, by the time that power is again supplied to the environment heater **111**, the temperature does not decrease as far as a level that causes problems in operation of the image forming apparatus **2100**.

After the value of the FET **215** ON/OFF signal **707** has changed to low, the value of the relay ON voltage **702** changes to low, the relay **204** is turned off, and the DC power supply **2205** is stopped (corresponding to Step S**604** of FIG. **19**). The CPU **131** confirms that the DC power supply **2205** has stopped based on the fact that the value of a reset signal by the DC power supply **2205** reset signal **705** has changed to low (corresponding to Step S**605** of FIG. **19**).

Then, the value of the second control circuit activation signal **704** changes from high to low, and the second control circuit **2203** is stopped (corresponding to Step S**606** of FIG. **19**). Next, the value of the FET **206** ON/OFF signal **706** changes from high to low, and the FET **206** is turned on. As a result, power feeding to the environment heater **111** is started (corresponding to Step S**607** of FIG. **19**), and the shift to the power saving mode is completed.

In the power saving mode, control is performed in this manner for maintaining the on state by switching the FET **206** from off to on. In that control, the power needed by the circuit executing the control is less than that in the control in which ON/OFF of elements such as the FETs **206** and **208** is repeated. It is preferred that the resistance value of the environment heater **111** be set to a value that enables control such as that described above to be performed in the power saving mode.

As described above, according to the second embodiment, the image forming apparatus **2100** has a power saving mode, and is configured to feed power to the environment heater **111** from the DC power supply **2201** during the power saving mode. When returning from the power saving mode, the power feeding path from the DC power supply **2201** is cut off. On the other hand, in the modes other than the power saving mode, power is fed to the environment heater **111** from the DC power supply **2205**, which has a higher output than the DC power supply **2201**. The voltage output from the DC power supply **2205** is higher than the voltage output from the DC power supply **2201**. Through performing control in this manner, in the image forming apparatus **2100**, sudden heating of the environment heater **111** during modes other than the power saving mode can be prevented and further consequences of such control can be suppressed.

## Third Embodiment

In a third embodiment of the present invention, power is supplied from the DC power supply **2205** to the second control circuit **2203** by using an image forming apparatus **2** in which the power efficiency during the power saving mode is further improved and the power supply capacity of the DC power supply **2201** is decreased. In FIG. **21**, a function block diagram of the image forming apparatus **2** is illustrated.

As illustrated in FIG. **21**, in the image forming apparatus **2**, the second control circuit **2203** is configured to control the temperature of the environment heater **111** by referring to output from the temperature sensor **210** to control the FET **215**. In the image forming apparatus **2100** described in the second embodiment, the first control circuit **2202** is configured to control the temperature of the environment heater **111** by referring to the temperature sensor **210** to control the FET **215**. As illustrated in FIG. **21**, the second control circuit **2203** is configured to receive the power feed from the DC power supply **2205**. In the normal power mode, the DC power supply **2205** is driven, and in the modes other than the power saving mode, the second control circuit **2203** is driven by the DC power supply **2205**. The third embodiment is different from the second embodiment in terms of that point.

In the power saving mode, similar to the second embodiment, the DC power supply **2205** is not driven, and hence the second control circuit **2203** does not receive the supply of power from the DC power supply **2205**.

With such a configuration, in the normal power mode, the second control circuit **2203** is configured to adjust the temperature of the environment heater **111**. Therefore, the first control circuit **2202** receiving the supply of power from the DC power supply **2201** is capable of suppressing power consumption without needing to adjust the temperature of the environment heater **111**. In particular, this configuration is advantageous when control having a large power consumption is necessary, e.g., repeatedly turning ON/OFF the FET **215** in order to control the environment heater **111** in the normal power mode. The reason for this is that the output of the DC power supply **2201** can be suppressed to a low level due to the fact that it is not necessary for the DC power supply **2201** to perform control having a large power consumption.

In the power saving mode, similar to the second embodiment, the first control circuit **2202** is configured to adjust the temperature of the environment heater **111**. Further, similar to the second embodiment, in the control of the environment heater **111** in the power saving mode, control is performed so that the power consumption is smaller than in the normal power mode. Such a configuration has an advantage in that output from the DC power supply **2201** can be suppressed to a level that is low enough to allow control having a low power consumption in the power saving mode to be performed. Other parts in the image forming apparatus **2** are similar to those of the image forming apparatus **2100**. The image forming apparatus **2** is configured to execute the control flowchart illustrated in FIG. **16**.

The processing executed in Step S**309** of the control flowchart illustrated in FIG. **16** in the third embodiment is illustrated in the flowchart of FIG. **22**.

After it is determined in Step S**308** of FIG. **16** that a request to return from the power saving mode has been input (Step S**308**: Yes), the CPU **131** turns off the FET **206** to cut off power feeding from the DC power supply **2201** to the environment heater **111** (Step S**801**). The CPU **131** then turns on the relay **204** to activate the DC power supply **2205** (Step S**803**).

The CPU **131** determines whether or not the second control circuit **2203** has been activated by detecting that a reset signal (not shown) of the second control circuit **2203** has been released (Step S**804**). When the reset signal is not released (Step S**804**: No), this means that the second control circuit **2203** is not activated, and hence the CPU **131** again executes Step S**804**.

When it is determined that the second control circuit **2203** has been activated (Step S**804**: Yes), the first control circuit **2202** issues an instruction to the second control circuit **2203** to start temperature control of the environment heater **111** (Step S**805**). The second control circuit **2203** turns on the FET **215** (Step S**806**) to start power feeding to the environment heater **111**, then refers to the temperature detected by the temperature sensor **210**, and performs temperature adjustment control so that the target temperature is maintained (Step S**807**).

Thus, in the third embodiment, the temperature of the environment heater **111** is controlled in the power saving mode by the first control circuit **2202**, and in the modes other than the power saving mode, such as the normal power mode, the temperature of the environment heater **111** is controlled by the second control circuit **2203**.

Next, the operation illustrated in Step S**306** of FIG. **16** of the image forming apparatus **2** when shifting from the normal power mode to, for example, a power saving mode such as a sleep mode, is described with reference to the control flowchart illustrated FIG. **23**.

After it is determined in Step S**305** of FIG. **16** that there is a request to shift to the power saving mode (Step S**305**: Yes; S**901**: Yes), the CPU **131** of the first control circuit **2202** in the system controller **2117** executes processing for shifting to the power saving mode by the first control circuit **2202** (Step S**902**). In the processing for shifting to the power saving mode, processing, e.g., backing up of the data necessary during operation, is performed. When the processing for shifting to the power saving mode ends, the CPU **131** of the first control circuit **2202** issues an instruction to the second control circuit **2203** to stop temperature adjustment of the environment heater **111** (Step S**903**).

In response to the instruction, the second control circuit **2203** turns off the FET **215** to cut off power feeding from the DC power supply **2205** to the environment heater **111** (Step S**904**). Next, the CPU **131** turns off the relay **204** to stop the AC supply to the DC power supply **2205** (Step S**905**), and determines whether or not the second control circuit **2203** has been reset (Step S**906**). When the second control circuit **2203** has not been reset (Step S**906**: No), Step S**906** is executed again. When the second control circuit **2203** has been reset (Step S**906**: Yes), the CPU **131** turns on the FET **206** (Step S**907**) to enable the path along which power is to be fed from the DC power supply **2201** to the environment heater **111**, and then completes the shift to the power saving mode (Step S**908**).

As described above, according to the third embodiment, as in the second embodiment, sudden heating of the environment heater **111** during modes other than the power saving mode can be prevented and further consequences of such control can be suppressed.

In the above-mentioned embodiments, examples are described in which the environment heater **111** is arranged in the sheet feeding cassette **124**. However, the environment heater **111** may be arranged in the image forming unit including a photosensitive drum to be used in image formation, or in the image reading unit **102**.

The above-mentioned embodiments are given just for the purpose of describing the present invention more specifically, and the scope of the present invention is not limited by the embodiments.

According to the present invention, an increase in power during the power saving mode can be suppressed by switching the power feeding source of the heater based on the mode.

While the present invention has been described with reference to exemplary embodiments, it is to be understood that the invention is not limited to the disclosed exemplary embodiments. The scope of the following claims is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent structures and functions.

This application claims the benefit of Japanese Patent Application No. 2015-176530, filed Sep. 8, 2015, No. 2015-176977, filed Sep. 8, 2015, and No. 2016-054256, filed Mar. 17, 2016 which are hereby incorporated by reference herein in their entirety.

What is claimed is:

**1**. An image forming apparatus having a first power mode and a second power mode in which power consumption is less than power consumption in the first power mode, the image forming apparatus comprising:

- a first power supply unit configured to operate in the first power mode and the second power mode;
- a second power supply unit configured to operate in the first power mode and not to operate in the second power mode;
- an image forming unit configured to form an image;
- a heater configured to heat the image forming unit;
- a first switch for controlling a supply of power from the first power supply unit to the heater;
- a second switch for controlling a supply of power from the second power supply unit to the heater; and
- a controller configured to (a), based on an instruction for shifting a power mode of the image forming apparatus from the first power mode to the second power mode, (i) turn off the second switch to stop supplying power from the second power supply unit to the heater, and (ii) turn on the first switch to start supplying power from the first power supply unit to the heater, and (b), based on an instruction for returning the power mode from the second power mode to the first power mode, (i) turn off the first switch to stop supplying power from the first power supply unit to the heater, and (ii) turn on the second switch to start supplying power from the second power supply unit to the heater.

**2**. An image forming apparatus according to claim **1**, further comprising a detector configured to detect a current of the first power supply unit, wherein the controller is configured to control the first switch and the second switch based on a detection signal from the detector.

**3**. An image forming apparatus according to claim **1**, further comprising a capacitive load connected in parallel to the heater,

wherein the capacitive load is configured to supply power to the heater at a timing immediately after a switch between the first power supply unit and the second power supply unit to the heater.

**4**. An image forming apparatus according to claim **1**,

wherein the second power mode comprises a power saving mode, and

wherein the first power mode comprises a standby mode for waiting for image formation to start.

**5**. An image forming apparatus according to claim **1**,

wherein the first power supply unit comprises a constant power supply unit, and

wherein the second power supply unit comprises a non-constant power supply unit.

**6**. An image forming apparatus according to claim **1**,

wherein the first power supply unit and the second power supply unit each comprise a direct current power supply unit, and

wherein the heater comprises a direct current heater.

**7**. An image forming apparatus according to claim **1**,

wherein the image forming apparatus is connectable to an external device via a network, and

wherein the image forming apparatus is configured to shift from the second power mode to the first power mode when a network response request is received from the external device when the image forming apparatus is operating in the second power mode.

**8**. An image forming apparatus according to claim **1**,

wherein the image forming unit comprises a photosensitive member, and

wherein the heater comprises a heater for heating the photosensitive member.

**9**. An image forming apparatus according to claim **1**,

wherein in the first power mode, power is supplied to the image forming unit from the second power supply unit, and

wherein in the second power mode, power supply to the image forming unit is stopped.

**10**. An image forming apparatus according to claim **1**, wherein the second power supply unit has a higher output than the first power supply unit.

**11**. An image forming apparatus according to claim **1**, wherein the first power supply unit and the second power supply unit are configured to be fed with power from an alternating-current power supply and to output a direct current.

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